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13. ABSTRACT *(Maximum 200 words)*
THE SCOPE OF THIS PROJECT IS TO PERFORM A SANITARY SEWER SURVEY AND PREPARE A MEMORANDUM REPORT TO INCLUDE FINDINGS, DETERMINATIONS AND RECOMMENDATIONS FOR FUTURE INVESTIGATIVE EFFORTS. THIS MEMORANDUM REPORT IS TO PRESENT THE VERIFICATION OF EXISTING SEWER MAPS, ESTIMATES OF INFILTRATION/INFLOW, SMOKE TESTING, VISUAL INSPECTIONS AND WATER QUALITY SAMPLING. PRESENTATION OF RESULTS, PROPOSED FUTURE EFFORTS, PRELIMINARY COST ESTIMATES FOR FUTURE WORK ARE PRESENTED AS AN INTEGRAL PART OF THIS PROJECT. MAPS INCLUDED.

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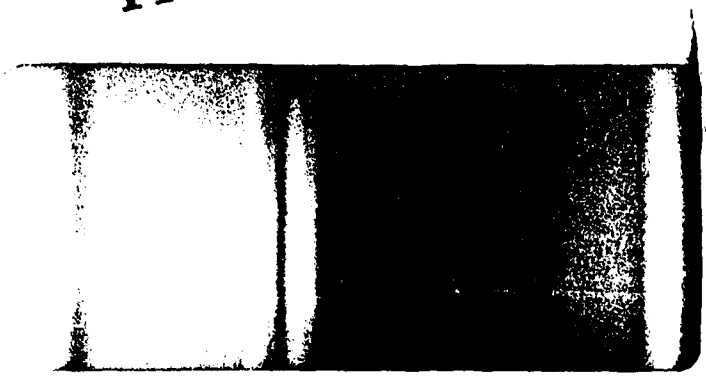

BLACK & VEATCH/consulting engineers

MEMORANDUM REPORT

SANITARY SEWERAGE SYSTEM REPAIRS

ROCKY MOUNTAIN ARSENAL-COMMERCE CITY,COLORADO

PREPARED BY

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

FOR

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

OCTOBER 1979

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CHAPTER I

A. AUTHORITY AND SCOPE

1. Authority. The project, Sewerage System Repairs, Rocky Mountain Arsenal, is authorized by the Notice to Proceed dated 1 August 1979, and is based on the requirements set forth in Contract No. DACA45-79-C-0019, Modification No. P00002.

2. Scope. The scope of the project, Sewerage Systems Repairs, Rocky Mountain Arsenal, is to perform a sanitary sewer survey and prepare a memorandum report to include findings, determinations and recommendations for future investigative efforts. The memorandum report is to present the verification of existing sewer maps, estimates of infiltration/inflow, smoke testing, visual inspections and water quality sampling. Presentation of results, proposed future efforts, preliminary cost estimates for future work are presented as an integral part of this project phase.

B. GENERAL DESCRIPTION OF WORK. A general investigative and land surveying appraisal of the existing sanitary sewer collection system was performed to determine the physical condition and location of the system tributary to the Rocky Mountain Arsenal wastewater treatment plant. Smoke tests, manhole inspections, water quality sampling and flow metering results provide the basis for the appraisal. As an integral part of this project, the contaminated sewer located principally in the South Plants industrial area at Rocky Mountain Arsenal and tributary to Reservoir F was located both vertically and horizontally relative to the sanitary system. On-site investigations through visual inspection of exposed portions of the total system, with particular emphasis on manholes, low areas, smoke test findings, constitute a significant part of the engineering appraisal.

CHAPTER II
STUDY AREA

A. DESCRIPTION. Rocky Mountain Arsenal consists of about 17,800 acres, 27.8 square miles and is located in the plains area immediately north of Denver, Colorado. The Arsenal is a major government installation and a chemical production center for the Shell Chemical Company. Industrial type facilities have been in operation at RMA since 1942. Production of toxic chemicals, chemical filled munitions or subsequent demilitarization has been performed at the Arsenal. In 1952, Shell Chemical Company purchased the Julius Hyman Company which had originally leased the south plant area. Shell Chemical Company is actively producing commercial products.

The sewage collection system for both contaminated and sanitary wastes is comprised of connectors, laterals, trunk lines, and appurtenant structures, and has undergone expansion and change since initially installed.

B. POPULATION. The population contributing to the wastewater collection system is comprised of military personnel, civilian employees of the Arsenal, and employees of Shell Chemical Company. There is presently no full time resident population at the Arsenal. The average daily population at RMA is reported to be: 300 permanent and 20 contract personnel, Shell Chemical Company and 350 employees, Rocky Mountain Arsenal. The Arsenal has staff personnel on location at all times, but the general working day is from 7:45 a.m. to 4:15 p.m. for Shell Chemical Company, except for approximately 120 employees assigned to operations which function on a 24-hour per day, seven-day per week schedule.

1. Future Population. It is reported that the anticipated future population will remain at nearly its present level.

C. GEOLOGIC CONSIDERATIONS. Rocky Mountain Arsenal is located in the South Platte River basin. The principal surface water drainage course is First Creek and ground-water movement is in a general northerly direction. Three soils groups predominate the area; they are: Fluvents-Sampson, Ascalon-Vona-Truckton and Platner-Ulm-Renohill. The soils of these three groups consist primarily of silty sands and sandy clays. For the most part, these soils appear to be tight, and well graded.

CHAPTER III

DESCRIPTION OF STUDY

A. DESCRIPTION OF METHODS USED.

1. Physical Survey. A physical survey of both the sanitary and contaminated sewer collection systems was performed. The survey consisted of the following:

a. Collection and review of available data from both Rocky Mountain Arsenal and Shell Chemical Company sources. These data include available system maps, wastewater flow records, ground-water elevation records, and current manhole inspection reports (SCC).

b. Physically located manholes for both systems and identified for future reference. Plan and profile information is presented on Drawings S-1 through S-18. Verification of available system maps was performed.

c. Inspect 192 sanitary sewer manholes on lines tributary to RMA wastewater treatment plant.

d. Searched for potential inflow source areas, e.g., broken pipe, uncovered manholes, low water crossings, etc.

2. Smoke Testing. Smoke testing of the inventoried sanitary sewer collection system was performed. It was anticipated that potential infiltration/inflow source areas not visually observed by previously discussed methods would be identified.

3. Flow Measurements. Flow measurements were obtained at ten locations within the system. Historical flow measurements were obtained for effluent discharges at the wastewater plant. The following general areas were chosen for initial flow monitoring during this phase of the project:

- South Plants Area - Manhole 96

Manhole 96 is located on the first straight run immediately north of the South Plants Area. All sanitary sewage generated within the defined South Plants Area theoretically flows through this manhole.

- Basin "A" - Manhole 75

Manhole 75 is the last manhole of the main sewer leading from the South Plants Area before being joined by the Administration Area sewer. This location was selected for two principal reasons. First, to document any losses or gains in sewage flow between the South Plants Area and through Basin A, and second, to establish total flow before joining with wastes originating from the Administration Area.

• Administration Area - Manhole 48

Manhole 48 is the furthest north, straight run manhole on the Administration Area line before joining with the main sewer. This location was selected to measure flows from both the Administration Area and intervening undeveloped land area.

• Reservoir F - Manhole 19

Manhole 19 was selected for purposes of documenting losses/gains along the main sewer line in the area of Reservoir F. The manhole is located immediately south of Ninth Avenue.

• GB Plants Area - Manhole S40

Manhole S40 located immediately west of the wastewater plant entrance road was selected to document flows generated in the GB plants Area.

The preliminary flow documentation effort was designed to isolate major potential problem areas. Following a review of flow data selected meters were moved to intermediate areas in order to gain a more detailed or discrete definition of infiltration and inflow.

The primary measuring devices were 60 degree V-notch weirs. Five Mannings dipper, twenty-four hour recording gages of the weighing type were utilized by the inspection crew. A float-actuated recorder is permanently installed at the RMA wastewater treatment plant and was also utilized for purposes of this study.

4. Areas Selected for Flow Measuring. The areas described below were initially selected for measuring sanitary sewage flows. The aggregated area contains Administration buildings, chemical producing facilities, laundries, laboratories, chemical demilitarization facilities, and various support operations. Numerous abandoned buildings and demolished structures are located tributary to the collection system.

The areas immediately north of the South Plants, Administration and GB Plants Areas are used for various purposes. Between the Administration Area and the main sewer, the only development noted was an earth lined pond, and an irrigation ditch. Between the South Plants and the wastewater plant there are the following: Basin A, a refuse dump area; Reservoirs C & F, liquid holding ponds; and assorted buildings, roads, and steam lines. The area north of the GB Plants is essentially undeveloped. All tributary areas not in use for disposal of wastes, etc., sustain a relatively thick vegetal cover.

5. Flow Measurement Period. Flow measurements were made for the expressed purpose of analyzing infiltration/exfiltration/inflow during periods listed below. Additional flow data was obtained from RMA personnel for the wastewater treatment plant.

Area	Manhole	Starting Date	Ending Date
Administration	48	9-1-79	9-17-79
South Plants	96	9-1-79	
Basin A	75	9-1-79	9-17-79
Reservoir F	19	9-1-79	9-17-79
GB Plants	S40	9-1-79	9-17-79
Basin A	88	9-17-79	Not Functioning
Reservoir F	34	9-17-79	
Reservoir F	27	9-17-79	
GB Plants	S34	9-17-79	
Treatment Plant	13	10-23-79	

6. Precipitation Measurements. Precipitation measurements were obtained at two locations during this project. Historical rainfall records concurrent with historical flow measurements were obtained from the Weather Bureau for the Denver, Colorado Stapleton Airport.

The rain gages were located to obtain data representative of the land area between the South Plants Area and the wastewater treatment plant. One gage was located due east of the fire station about 125 feet north of December 7th Avenue and the second gage was positioned about 160 feet north of the treatment plant trickling filter.

7. Precipitation Measurement Period. Precipitation measurements were made for the expressed purpose of identifying and analyzing infiltration and inflow quantities during the period of study. Two Bendix Universal Rain Gauges of the 24-hour spring type mechanisms were used to record the rainfall at the study area. Rainfall records were compared with treatment plant flow records and attempts at correlation were made.

CHAPTER IV

COLLECTION SYSTEM

A. DESCRIPTION. The following information has been obtained from field surveys, maps, and discussions with Rocky Mountain Arsenal and Shell Chemical Company personnel. There are about 9.7 miles of sanitary sewers ranging in size from 4 inches to 24 inches in the collection system. One sanitary sewer force main is in service within the Arsenal. This force main runs from the housing area located northwest of "C" Street and December 7th Avenue to Manhole 65, north of the Administration building. Flow pumped through this line includes flow from the housing area, the officers' mess, and restroom facilities at the swimming pool. The lengths of these sanitary sewer lines are not included in the inventory of sanitary lines. The Arsenal was divided into four subareas for data collection and presentation: South Plants Area including sewer line "B" downstream to the junction of Manhole 46 with sewer line "A" from the Administration Area; the Administration Area including sewer line "A" downstream to the junction with sewer line "B"; the sewer downstream of the junction of the South Plant and Administration sewer lines to the wastewater treatment plant; and, the GB Plants Area. Table 1 presents in summary form, an inventory, by sewer size and subarea, the lengths of the sanitary sewers in the study area.

The sanitary sewage collection system is constructed primarily of vitrified clay pipe, with small lengths of cast iron pipe in the South Plants and GB Plants Areas.

The sanitary sewer system at the Rocky Mountain Arsenal is primarily a gravity system. In addition to the force main described previously, there are three sanitary sewer lift stations located within the South Plants Area. No engineering appraisal of these stations was made during this study.

TABLE 1

LENGTHS OF SANITARY SEWERS

Size (inches)	South Plants Area (feet)	Administration Area (feet)	Manhole 46 to WWTP (feet)	GB Plants Area (feet)	Total (feet)
4	480				480
6	7,175			447	7,622
8	3,840	1,140		2,236	7,216
10	335			7,270	7,605
12	4,095	6,345			10,440
18	5,221		11,448		16,669
24	1,172				1,172
Total	22,318	7,485	11,448	9,953	51,204

The contaminated sewers within the South Plants Area and the sewer line from South Plants to Reservoir F were located relative to sanitary sewers. Lengths and pipe sizes of the contaminated sewer system, exempting all contaminated sewers originating in the GB Plants Area, are summarized in Table 2.

TABLE 2

LENGTHS OF CONTAMINATED SEWERS

Size (inches)	South Plants Area (feet)	North of 7th Avenue to Reservoir F (feet)	Total (feet)
4	340		340
6	2,695		2,695
8	1,045	5,636	6,681
10	1,975	10,011	11,986
12	2,260	1,179	3,439
Total	8,315	16,826	25,141

B. FLOW DATA. There were no sewage flow data available for the sewage treatment plant during and immediately following the August 1979 rainfall events. Therefore, correlation between metered flow data and the treatment plant records for rain events did not produce sufficient results. Also, the metering performed for this study was temporarily delayed by three weeks due to shipping problems encountered with the supplier. This was unfortunate since most of the rainy weather did occur between the middle and end of August, and the meters were not installed in time to record these events. Therefore, most of the analyses must wait until more data can be gathered.

CHAPTER V
STUDY RESULTS

A. SMOKE TESTING: Smoke testing of the Rocky Mountain Arsenal sewers was used to detect inflow sources. To date, 100 percent of the system's sewers have been smoke tested, corresponding to 51,204 ft. of pipe. Below is a list of the completed number of smoke tests:

Area*	No. of Smoke Tests Completed
South Plants	61
Administration	15
MH 46 to WWTP	21
GB Plants	20

*See Chapter IV, Paragraph A for description of areas.

Table 3 shows a summary of potential inflow sources where smoke was observed to escape from the sanitary sewer during the smoke tests.

During smoke testing operations, lines were encountered which would not pass the smoke. The obstruction could either be a dip in the line which forms a water trap, a blockage of trash, or a partially caved-in sewer pipe. Below is a list of the blockages:

Area	Test at Manhole	Between Manholes
South Plants	111G	111G, 111I
South Plants	S6	S6, S7
Administration	71	71, 74A

Inasmuch as the sanitary sewer lines are highly suspected of being in poor condition, the majority of them did not prove to be faulty by smoke testing operations. This is believed to be due to the hard, compacted sandy-clay soil and high moisture contents. This type soil has few cracks in the surface, and being compacted, will not allow the smoke to exit from the broken or cracked sewer lines. This was not anticipated before the start of the smoke testing operation, and as a result very few inflow sources were located. The absence of smoke should not be construed to mean that sanitary sewers are not faulty.

TABLE 3

POTENTIAL INFLOW SOURCES

Area*	Manhole Test Reference No.	Inflow Source	Location
South Plants	89	Broken Bells of Exposed Pipe	NW of MH 89 at Pipe Crossing in Basin A
Administration	47	Prairie Dog Hole	6 Feet N. of MH 47 on Sewer Line
Administration	57	Prairie Dog Hole	5 Feet E. of MH 59 on Sewer Line
Administration	57	Prairie Dog Hole	60 Feet E. of MH 58 on Sewer Line
Administration	59	Prairie Dog Hole	108 Feet W. of MH 59 on Sewer Line
Administration	61	7 Prairie Dog Holes	On Sewer Line Between MH's 61 and 62
Administration	72	Broken or Cracked Lateral	Lateral from Administration Building to Sewer Line Between MH's 72 and 73
GB Plant	S31	Abandoned Building Connection	30 Feet W. of Sewer Line Between MH's S30 and S31
GB Plant	S33	Abandoned Building Connection	3 Concrete Slabs W. of Sewer Line and E. of Buildings 1614-1616

* See Chapter IV, Paragraph A for Area Descriptions

B. FLOW METERING: Although a thorough analyses of the flow metering cannot be given at this time, there are, however, some indications of inflow/infiltration and exfiltration. From MH's 96 to 75 the meter results indicate an increase of inflow of approximately 20 percent in dry weather. The groundwater level in that area is below the inverts by as much as 2-1/2 ft. to 7 ft. The only explanation is that there was approximately 15 ft. of exposed 18" diameter pipe with broken bells located in Basin A between MH's 89 and 90. This exposed pipe rests in a ponding area where water will collect and enter directly into the system. From MH's 75 to 19 the meters indicate a decrease in flow of approximately 50 percent. By moving the meter from MH 19 to MH 27 it was found that most of the loss was near the Basin F area. More accurate definition of inflow locations should be available when the results of the flows measured at MH 34 are analyzed.

The flow in the sanitary sewer lines generated in the GB Area was not sufficient to cause water to flow over the V-notch weir in MH S40. Although a constant flow was observed upstream as far as MH S14, most of it was visually observed to disappear by the time it reached MH S34. This would appear to indicate that a break in the line exists and exfiltration is occurring from the sewer line in this area. In order to better define this problem area, the meter initially installed in MH S40 was moved to MH S33. Because of start-up of operations within the GB Area, no flow metering results have been obtained to date.

C. INFLOW: Potential inflow was estimated for each source located during the smoke testing. The flow was based on the type, size, and location of opening.

The inflow from roof drains or from holes in the ground was estimated on the basis of the rational formula for stormwater runoff. A rainfall intensity of 0.5 inches per hour was used which is the 5-year frequency, 2 hour 45 minute duration storm for the Denver area. This duration was selected by adding a 5-minute inlet time to the longest travel time in the sewerage system, yielding a total time of concentration of two hours and 45 minutes. A runoff coefficient of 0.95 was used for roofs and pavements, and a coefficient of 0.65 was used for turf and unpaved areas. These coefficients were selected from the higher end of expected range of values for coefficients because it was assumed that a 2-hour 45 minute duration rain would saturate the ground.

The inflow from all sources was assumed to determine the total inflow of 29,175 gpd entering the system. The total flow in the collection system is summarized as follows:

Total estimated inflow	29,175 gpd
Peak base flow	25,000
Total flow entering system	54,175 gpd
Exfiltration from system*	31,675
Total flow reaching treatment plant	22,500 gpd

* Estimated from preliminary flow meter data.

A more detailed analyses will be made upon gathering more metered flow data and from rainfall charts as the study period continues.

D. WATER QUALITY AND GROUNDWATER: Two samples each were tested on different dates from the Manholes listed in Table 4 on the following page. Each sample was tested for DBCP, ALDRN, ISODR, DLDRN, ENDRN, DIMP. The toxicity levels for these chemicals in micrograms per liter are as follows: DBCP-0.2; ALDRN-hold to a minimum; DLDRN-hold to a minimum; ENDRN-0.2; and DIMP-500. From Figures 1 and 2 the levels of DBCP and ALDRN in most of the sampled manholes are far in excess of the limits. The only chemical which was not in excess of the limits was DIMP. A general correlation can be made from Figure 1 which shows a trend for the DBCP to decrease as the samples are taken downstream. The groundwater near MH 115A and 116 is apparently infiltrating into the sanitary sewer system. These two manholes are in the South Plants Area in the vicinity of where DBCP was originally produced and/or stored. Production of DBCP was produced in Building 471 and halted on February 1976. The fact that the chemical is showing up in toxic amounts in the manholes is evidence that DBCP is present in the ground in appreciable amounts and that groundwater is infiltrating into the system.

From visual inspections of MH's 86 to 79, it was observed that MH 86 had more flow than MH 82, although both had dark colored water. MH 80 had more flow in it than MH 82 and was much cleaner in color, almost clear. Therefore, it may be concluded that exfiltration as well as infiltration is occurring in the reach of the system between MH's 96 and 75. The meter installed in MH 88 has been found to be defective and the readings cannot be used with reliability. It was to be replaced with a new flowmeter and at a later date installed in MH 13.

E. PHYSICAL CONDITION: Manholes in the system were inspected to locate obvious sources of extraneous water and to determine the general condition of the system. All sanitary manholes in the study area were inspected with the exception of those manholes in areas where access was denied.

A data sheet was compiled for each manhole describing the physical condition of the manhole covers, corbels, walls, steps, aprons, and inverts. Copies of these data sheets will be supplied as an Appendix to the final report. Table 5 summarizes the results of the manhole inspections by subarea (see Chapter IV, Paragraph A for subarea descriptions).

TABLE 4

RESULTS OF SAMPLES TAKEN FROM THE
SANITARY SEWERS

	MH 17		MH 20		MH 34		MH 35		MH 38		MH 44		MH 49	
TEST*	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
DBCP	239	203	228	220	165	233	256	219	0.39	0.59	261	195	0.34	0.2
ALDRN	3.75	3.32	2.81	3.83	1.0	3.76	2.73	3.4	1.0	1.0	3.05	3.38	1.0	0.1
ISODR	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DLDRN	2.08	1.61	1.85	1.84	1.3	1.86	1.79	1.42	0.5	0.5	1.59	1.29	0.5	0.5
ENDRN	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DIMP	2.0	2.0	2.9	2.0	2.0	2.0	2.4	2.0	2.0	2.0	2.5	2.0	2.0	2.0

	MH 76		MH 79		MH 89		MH 97		MH 101		MH 116		MH 115-A		MH SA-2	
TEST*	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
DBCP	307	266	333	278	321	266	2.50		0.7	0.2	348	341	393	381	4.98	7.0
ALDRN	4.02	3.8	2.36	2.7	3.39	1.84	2.45		1.0	1.0	1.89	4.3	4.84	3.24	1.0	1.0
ISODR	0.5	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.74	0.5	0.5	0.5
DLDRN	1.85	2.27	1.91	1.83	1.76	1.57	1.37		0.5	0.5	0.72	1.63	2.38	1.79	0.87	0.5
ENDRN	0.57	0.55	0.55	0.51	0.64	0.5	0.54		0.5	0.5	0.5	0.66	0.68	0.74	0.5	0.5
DIMP	2.2	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.6	2.0	2.0

	MH 13		MH 26		MH 32		MH 36		MH 42		MH 55		MH 85	
TEST*	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
DBCP	59.9	50.2	70.5	55.2	65.2	69.2	65.3	66.3	68.4	62.6	0.2	0.26	98.9	89.0
ALDRN	3.67	11.1	2.65	8.0	2.9	3.45	2.9	2.37	1.34	2.47	1.0	1.0	4.11	1.0
ISODR	0.5	0.84	0.5	0.56	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.56	0.5	0.5
DLDRN	0.99	3.9	1.53	1.91	1.83	0.85	0.5	0.5	0.5	0.64	0.5	0.5	0.5	0.5
ENDRN	0.5	0.66	0.5	0.51	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DIMP	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

* Levels of chemicals in micrograms per liter.

TABLE 4
(Cont'd)

RESULTS OF SAMPLES TAKEN FROM THE
SANITARY SEWERS

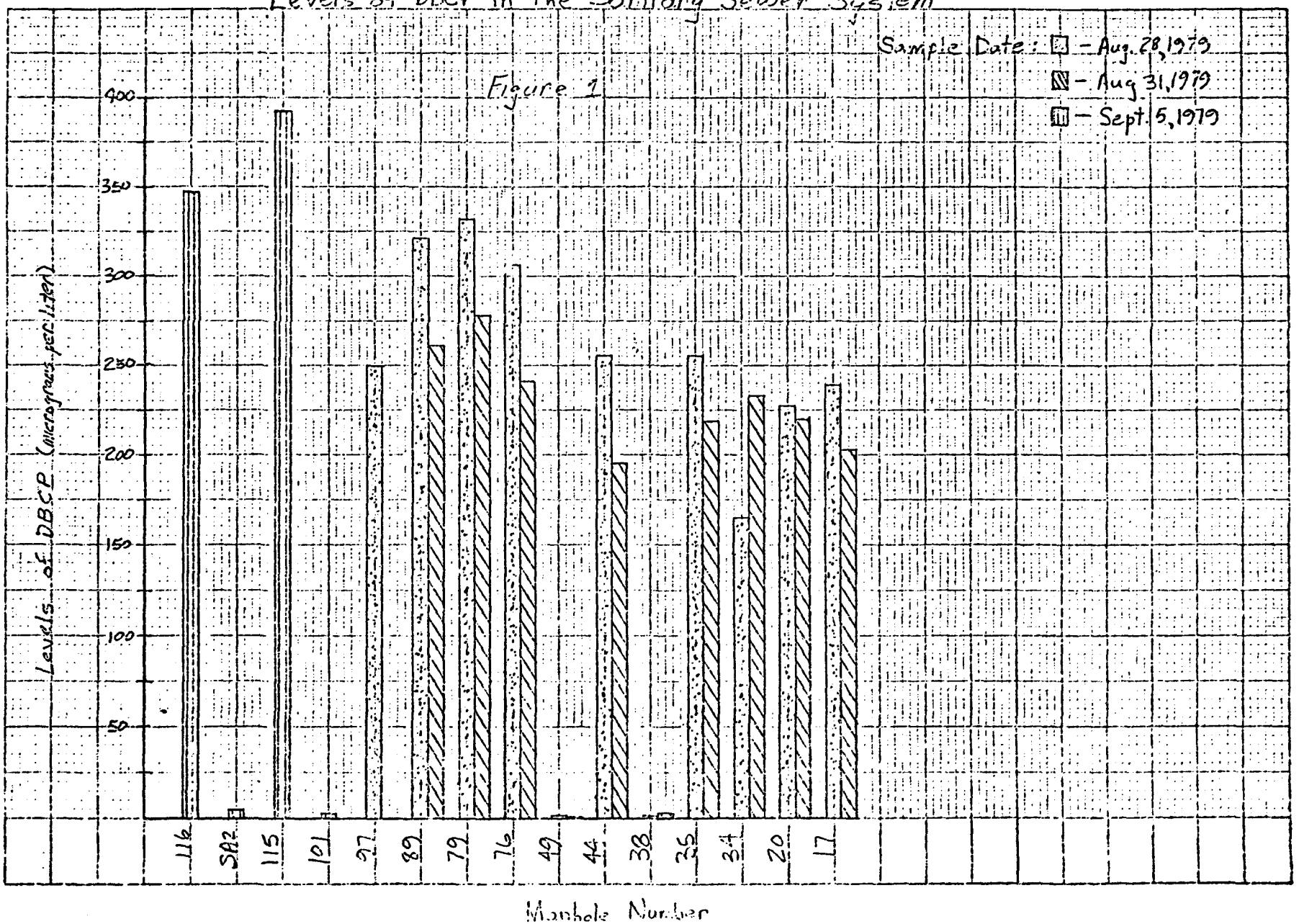
	MH 92		MH S35		MH S34		MH S27		MH S15		MH 123		MH 105		MH 119B	
TEST*	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
DBCP	101	98.3	0.2	0.69	0.2	0.63	0.2	0.22	0.2	0.29	19.7		0.38	0.29	0.2	422
ALDRN	2.5	1.28	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	9.48		1.0	1.0	1.0	1.0
ISODR	0.5	0.5	0.5	0.56	0.5	0.5	0.5	0.56	0.5	0.5	0.5		0.5	0.56	6.07	0.5
DLDRN	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	126		0.5	0.5	4.96	1.0
ENDRN	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.23		0.5	0.5	0.5	0.5
DIMP	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0

	MH 125	
TEST*	1st	2nd
DBCP	0.73	4.05
ALDRN	1.0	1.0
ISODR	0.5	0.56
DLDRN	2.09	0.5
ENDRN	0.5	0.5
DIMP	2.0	2.0

*Levels of chemicals in micrograms per liter.

Levels of DBCP in the Sanitary Sewer System

Figure 1



Levels of ALDRN in the Sanitary Sewer System

Figure 2

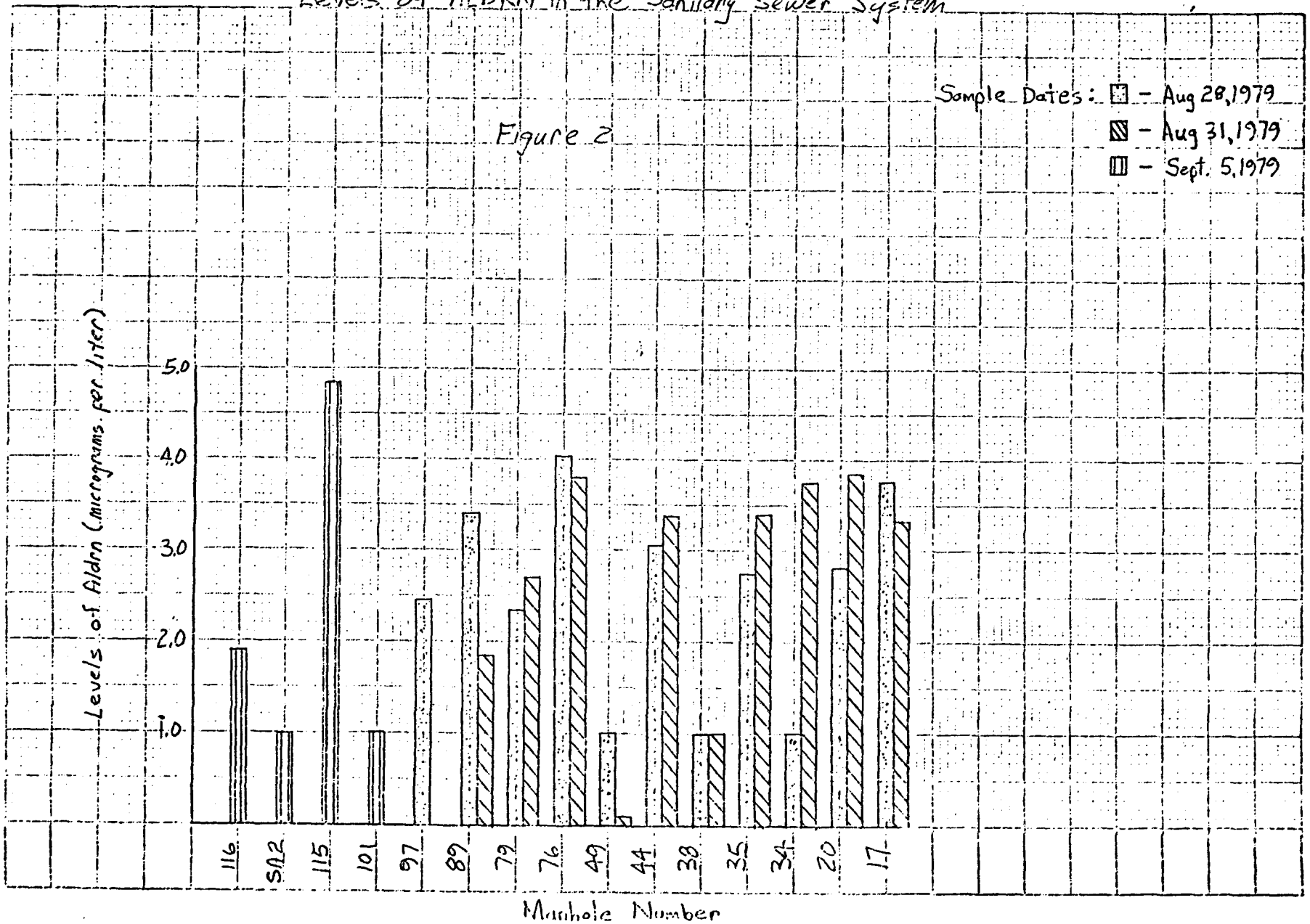


TABLE 5

GENERAL CONDITION OF SANITARY SEWER MANHOLES

Area	Number of Manholes Inspected	Condition of Manholes		
		Good	Fair	Poor
South Plants Area*	92	35	35	22
Administration Area	27	5	20	2
Manhole 46 to WWTP	37	1	27	9
GB Plants Area	36	19	16	1
Total	192	60	98	34

*Includes manholes from number 75 to 97.

As shown in the table, thirty-four manholes, or eighteen percent of the sanitary sewer manholes, are in poor condition and would require extensive work or replacement. Ninety-eight manholes or fifty-one percent, would require cleaning and minor remedial work and are considered to be in fair condition. The remaining sixty manholes, or thirty-one percent, are in good condition and would require little or no remedial work. It should also be noted that the steps in eighty percent of the manholes are in poor condition. The following paragraphs describe the manholes which are considered to be in poor condition.

In the GB Plants, MH S28 had 8 to 10 feet of dirt in the bottom, effectively plugging the manhole. The next upstream manhole, S23, has a fire hose inserted that is used to pump accumulated sewage from the manhole onto the ground surface. Two manholes within the GB Plants Area, S6 and S22, have metal pipes connecting them to adjacent fire hydrants. These manholes were used to generate make-up water for the wastewater treatment plant. However, this practice was discontinued in December 1978. Manhole S36 does not have a cover, but does have an outhouse built over it.

Manholes 50 and 65 are in the worst condition of the manholes in sewer line "A" from the Administration Area. These manholes had broken bricks and cracked mortar in the walls and the inverts and aprons were in very poor condition. The manholes along this line are mostly in fair condition, however they may have cracked or broken inverts. On the sewer line from Manhole 46 to the wastewater treatment plant, there are nine manholes in poor condition: 11, 24, 27, 28, 37, 38, 39, 40, and 44. Deficiencies common to these manholes are cracked and/or missing sections of the corbel, corroded steps and dirty, cracked aprons and inverts. The manholes adjacent to Reservoir F also contained odors somewhat similar to those experienced in the South Plants.

There are nine manholes in poor condition in sanitary sewer line "B". These include 79, 81, 82, 83, 84, 85, 86, 87, and 89. These manholes contained cracks in the walls and aprons, and in several manholes the pipe joints have separated. A portion of the sewer line between Manholes 89 and 90 was exposed and the smoke testing revealed cracked bell joints. The nine manholes listed above are included in the South Plants total in the table.

During the inspection of manholes within the South Plant, several manholes were found with small (1 to 4 inch) pipes entering the manhole. The source of these pipes could not be determined and flow was observed on occasion. The chemical odor from some of the manholes required the use of gas masks during inspection, with Manhole SA-2 being one of the worst. Manhole inspections in the South Plants Area required that crews be accompanied by Shell personnel. Manhole 116 has what appears to be steam line drain entering through the corbel. When first opened, inspection was impossible because of steam within the manhole. Manhole 124 has cracked walls and aprons and showed evidence of seepage into the manhole. The corbel of Manhole 98 is in poor condition and Manhole 102 needs a new cover. Many other manholes have cracked aprons, and cracked or disjointed inverts. Particularly poor manholes include B, 103A, 103B, and 125B.

F. MANHOLE REPAIRS: The manhole inspection program addressed the physical conditions of more than 190 sanitary sewer manholes. The following items were checked during the inspection process: cover, leveling bricks, taper or corbel, walls, steps, aprons, and inverts. Based upon the inventory, five cases were established for assigning rehabilitation costs for the manholes. A description of each case, rehabilitation and costs follow.

- Case I: Manhole interior in poor condition: missing or broken bricks in walls and corbel, deteriorated mortar, aprons and inverts broken/chipped.
  Rehabilitation: Mortar interior of manhole and grout aprons and inverts.
  Estimated Cost: $460.00/manhole

- Case II: Manhole walls and corbels with missing or broken bricks, and mortar deterioration.
  Rehabilitation: Mortar manhole interior
  Estimated Cost: $360.00/manhole

- Case III: Manhole aprons and inverts are cracked or broken
  Rahabilitation: Reconstruct with grout
  Estimated Cost: $100.00/manhole

- Case IV: Manhole cast-iron steps are broken or deteriorated to the extent that personal safety is in jeopardy.
  Rehabilitation: Replace existing steps with polyethylene steps.
  Estimated Cost: $25.00/step

- Case V: Manhole cover missing or broken.
  Rehabilitation: Replace with new cover
  Estimated Cost: $100.00/cover

The number of manholes requiring rehabilitation in each case is listed below with their respective costs.

Case	I	II	III	IV	V
Number of Manholes	19	19	28	140*	3
Estimated Cost	$8,740.	$6,840.	$2,800.	$10,800.	$300.

* Total number of steps 432.

The total cost estimate for manhole repair is $29,480. The estimated repair cost can be appreciably reduced in the event sliplining is accomplished throughout the sanitary system. The sliplining process can effectively reduce the number of required manholes, thus reducing the need for costly rehabilitation work.

G. EXTRANEOUS FLOWS: Extraneous flows consisting of infiltration and inflow currently mixing with the sanitary sewerage within the existing collection system will continue to collect in the sewer following sliplining. In order to assure that these flows do not contaminate the biological treatment process, it will be necessary either to divert these flows into Basin F or around the existing Imhoff tanks directly into the activated carbon treatment system located at the wastewater plant.

Flow measuring of the sewerage system indicates a minimum of extraneous flow downstream from Manhole 33. Therefore, it is suggested that a new, 12.5 feet deep, pre-cast concrete manhole be installed in the vicinity of Manhole 33 with an 8-inch polyethylene gravity-line leading to Basin F. The sanitary flow would pass directly through the manhole in the slipline pipe at about 6 feet above the manhole bottom. The gravity line would exit the manhole through the bottom.

The estimated cost for this diversion structure is $5,200.

H. OTHER CONSIDERATIONS

1. Alinement. The General Sanitary Sewer and General Contaminated Waste Sewer maps as provided to Black & Veatch have been modified to reflect correct alinement as ascertained through field surveys. The contaminated waste sewer between Eighth Avenue and Reservoir F, and the sanitary sewer line from Manhole 36 to Manhole 32 in the vicinity of Reservoirs C and F are two of the principal map realinements. Sheets S-2, S-7, S-14, and S-15 show the relocations of the above sewer lines. The South Plants Area map was redrawn utilizing field survey data and information provided by the Shell Chemical Company and the Rocky Mountain Arsenal. Sheets S-17 and S-18 show the location of sanitary and contaminated waste sewer lines in the South Plants Area.

2. Manholes. Manhole 56 on sanitary sewer line "A" from the Administration Area was not located in the field even with the aid of "As-Built" drawings and a metal detector. The approximate location of this manhole is shown on Sheet S-4. An additional manhole was field located on sanitary sewer line "B" from the South Plants Area between Manholes 84 and 85 shown on the General Sanitary Sewer map.. This manhole was numbered Manhole 84 and Manholes 83 and 84 were renumbered Manholes 82 and 83, respectively. See Sheet S-6 for the location of these manholes.

3. Air Pressure Test. A section of sewer line between MH 48 and MH 49 was pressure tested to determine the validity of the smoke test. Two smoke bombs were placed in the line and both ends of the sewer pipe were sealed. Pressurized air was then introduced into the line. No pressure could be built up in the line and no smoke was observed coming out of the ground. It can be concluded from this test that the sewer line is in poor condition and that interpretation of smoke testing results must be reflective of this special test.

4. Permit Requirements. During the early stage of this project, contacts were made with the following Federal, state and local agencies for the purpose of ascertaining permit requirements for remedial work on the Rocky Mountain Arsenal Sanitary Sewerage Collection System.

Denver Board of Water Commissioners
Colorado State Department of Health
Colorado State Department of Natural Resources
U. S. Environmental Protection Agency, Region VIII
Rocky Mountain Arsenal
Shell Chemical Company

The following is a synopsis of these contacts.

Denver Board of Water Commissioners

Jurisdiction stops at the Arsenal boundary. There are no wells in vicinity of Arsenal, and their water intakes are upstream of RMA.

Colorado State Department of Health

Division of Water Pollution Control. There are no permit requirements although trench dewatering water and any sanitary sewer solid wastes collected during excavation or cleaning should be disposed of in Basin F and not through the wastewater treatment plant.

Colorado State Department of Natural Resources

No permit requirements were noted.

U. S. Environmental Protection Agency

No permit requirements were noted. It was noted that a more stringent NPDES permit may be issued in near future for the existing wastewater plant. There may be permit (NPDES) requirements for any new treatment plant system installed at the Arsenal.

Rocky Mountain Arsenal

No permit requirements.

Shell Chemical Company

No permit requirements. A letter concurring with recommended remedial work from the plant manager would, however, be required.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Smoke testing did not provide sufficient information upon which to base an evaluation of the sanitary sewer's condition.

2. Tight, well graded soils and relatively high moisture contents inhibited the movement of smoke through soil.

3. Air pressure testing of one select sewer reach indicated a leaky pipe. Smoke testing of the same reach indicated a non-leaky pipe.

4. Manhole inspections indicate remedial measures are needed throughout the present sanitary sewer system.

5. Visual observations of the amount of sewage flow at successive manholes indicates the loss of flow in some reaches of pipe.

6. Sewer flows were visually observed to increase immediately following rainfall events indicating that inflow sources exist in the system. Abandoned and razed buildings are potential inflow sources.

7. Flow metering at various locations along the sanitary sewer system indicates that flow is being lost and/or gained along the length of the system.

8. Contaminated sewers that cross or run parallel to sanitary sewers have inverts that are 1 to 6 feet lower than the adjacent sanitary sewer. Flow observed in the contaminated sewer could be inpart exfiltration from the sanitary sewers.

9. Flow meter records at the wastewater treatment plant are incomplete.

10. Flow meter records at the wastewater treatment plant are not good indicators of peak inflow events because of the attenuation caused by the Imhoff tanks and the trickling filters located upstream of the recording device.

11. Chemical odors were detected in the sanitary sewers at several locations in the system.

12. The sanitary sewer is below ground-water levels in several areas within the South Plant.

13. Chemical samples indicate contaminant leakage into the sanitary sewer system is occurring, particularly in the South Plant Area.

14. Dilution of the contaminants observed in South Plant sewage flows is occurring downstream in the system as evidenced by the chemical sampling program.

15. Sampled levels of DBCP, Aldrin, Dieldrin, and Endrin exceed recommended levels. These contaminants are a probable cause of the death of bacterial growth necessary for proper operation of the trickling filters.

16. Existing plan drawings of the contaminated and sanitary sewer systems are relatively good. Minor relocations and scaling discrepancies were noted.

17. No permit requirements for possible future sewer improvements were discovered during this study.

18. Further investigations of the sanitary sewer system using dye studies, pressure testing, or television survey are not warranted.

19. Sliplining will not eliminate extraneous flows from reaching the waste water treatment plant.

20. Following sliplining of the sewer collection system, extraneous flows can be diverted to Basin F near Manhole 33 or can be routed around the wastewater plant directly into the activated carbon column.

RECOMMENDATIONS

1. Continue metering the sanitary sewer discharges.

2. Relocate selected meters in order to better define flow characteristics within the system.

3. Begin a program to disconnect sewer connections from razed and permanently abandoned buildings.

4. Perform an economic evaluation of the alternatives to eliminate the problems in the sanitary sewer system. Two of possible alternatives are:

   a. Complete rehabilitation of the existing sanitary sewer system by means of sliplining the existing sewers.

   b. Abandon the existing wastewater treatment plant and the sewer system except the South Plant Area, slipline South Plant sewers, and provide separate package plants for the Administration, GB Plants, and South Plants Areas.

COST ESTIMATES

Preliminary cost estimates for performance of work associated with remedial measures are as follows:

a. Sliplining total sanitary sewer collection system without service connections - $550,000.

b. Sliplining South Plants Area sanitary system - $192,000.

c. Manhole repairs - $29,480.

d. Diversion of extraneous water - $5,200.

*e. Wastewater treatment plant, South Plant - $110,000.

*f. Wastewater treatment plant, GB Plant - $90,000.

*g. Wastewater treatment plant, Administration Area - $90,000.

h. Engineering cost evaluation - $15,000.

* Assumed contributing populations and flows:

South Plant, 600 , 60,000 gpd

GB, 200 , 20,000 gpd

Administration, 200 , 20,000 gpd

Wastewater package plant cost provides for oversized aerators and clarifiers. Discharge from plants assumed to be to nearest drainage channel.

Comments on Interim Report
for Sanitary Sewer Repairs
Rocky Mountain Arsenal

1. When chemical tests are completed can a conclusion be reached regarding sources of chemical contamination? Will slip-lining and/or sewer replacement give reasonable assurance that chemical contamination will be reduced to an acceptable level?

2. Will TV surveys be required to define scope for slip-lining or can this be done as a part of the construction contract?

3.

4. Since the smoke testing was for the most part, inconclusive, can we assume with reasonable safety that there are no cross connections? Chemical sewer interconnections are of particular concern.

5. If package plants are selected, the abandoned sewer will probably act as a subdrain which would discharge chemical contamination at the outfall. Report should address this possibility and remedial measures required.

6. Is sufficient data available at this time to proceed with economic analysis?

7. Costs, if any, involved in upgrading existing plant should be added to repair costs for a valid cost comparison.

8. Consideration must be given to the possibility that chemical contamination could exist following slip-lining. This would be particularly applicable to a package plant at the South Plants Area.

ROCKY MOUNTAIN ARSENAL

SANITARY SEWERAGE SYSTEM REPAIRS

Responses to Omaha District, COE, Comments:

1. The water quality sampling program has been completed. The results of the most recent analytical testing have been incorporated into the project report.

   At best, the water quality data collected during this project indicates that contamination of the sanitary sewerage collection system is occurring in the South Plants area in vicinity of manholes 115A, 116, and 119. Statements regarding specific source locations are not advisable.

   Sliplining the entire sanitary sewerage collection system should effectively reduce the amount of contamination currently entering the system through infiltration and being transported to the wastewater treatment plant.

   Contamination resulting from pollutants entering the system through floor drains would still occur, unless such drains were removed from the sanitary system.
   Infiltration of groundwater would still occur even with sliplining. Provisions for removing this extraneous flow from the sewer system could effectively be accomplished in the vicnity of Basin F or immediately before entering the wastewater treatment plants' Imhoff tank.

2. A television survey of the entire system is not believed to be required for defining the scope of sliplining efforts. Television would, however, be quite effective in ascertaining whether or not sliplining can be readily accomplished in smaller size pipes. Pipe displacements, points of inflow, obstructions, etc., could be readily identified and corrective measures taken before sliplining takes place.

3.

4. Results of the smoke testing program under Phase I indicate the absence of direct cross connections between the sanitary and contaminated sewers. No smoke was observed coming out of contaminated manholes during testing of sanitary lines. There remains the possibility that ground water carries contamination from the industrial sewer to the sanitary sewer in the South Plants area. Testing for this condition was not performed in this phase of the project.

5. A/E agrees with the comment and has included a section in the report. Appropriate cost information has also been developed.

6. For the most part, yes. A/E would need to collect data relevant to RMA carbon columns and costs associated with physical-chemical package plants. These data should be readily obtainable.

7. A/E agrees. To be considered in Phase II.

8. A/E agrees. To be addressed further in Phase II.

ROCKY MOUNTAIN ARSENAL

SANITARY SEWERAGE SYSTEM REPAIRS

Responses to RMA and Shell Chemical Company Comments:

Shell Chemical

1. A/E concurs.

2. A/E has revised referenced section.

3. Appropriate revisions have been made in the prose.

4. A/E has removed the reference to smoke exiting storage tank T-1510 from the Memorandum Report. The A/E understands that Shell personnel have verified that there is no connection between T-1510 and the sanitary sewer. However, it remains that smoke was observed coming from a vent pipe on T-1510 at the time smoke testing was underway near the tank.

5. A/E informed by COE/Omaha that standards established by the State of Colorado should be used. These standards were used in draft report. No further action required.

6. No response required.

7. No response required.

RMA

1. No response required.

2. Manhole repair work has been addressed in final report.

3. No response required.

4. No response required.

DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO 80022

SARRM-TOC 19 Oct 79

SUBJECT: Memorandum Report, Sanitary Sewage System Repairs, Black and Veatch

District Engineer
Omaha District
US Army Corps of Engineers
ATTN: MROED-MF (George Williams)
6014 USPO and Court House Building
215 North 17 Street
Omaha, Nebraska 68102

1. Subject Report has been reviewed by RMA and Shell Chemical Company personnel.

2. SCC has provided comments (Incl 1) that should be incorporated into the final report prior to issue. RMA concurs in the Shell comments and notes that the Report does not address repair work which will be required to numerous manholes.

3. In a meeting at RMA on 17 Oct, RMA, Shell, ARRCOM, and DARCOM personnel agreed that Phase II of the study, i.e., TV inspection, is required to further define cost estimates for repairs and assist in identifying the available option for repair/replacement techniques.

4. Request that Phase II be scheduled to commence as soon as possible.

FOR THE COMMANDER:

Irwin M. Glassman

IRWIN M. GLASSMAN
Director of Technical Operations

1 Incl
as

CF:
ARRCOM: ATTN: DRSAR-ICS
DARCOM: ATTN: DRCIS-RI-IC

10/19/.

SHELL COMMENTS ON BLACK & VEATCH DRAFT MEMORANDUM
EPORT - SANITARY SEWERAGE SYSTEM REPAIRS

1. Page II-1, paragraph 1, line 4: Delete the word "major".

2. Page II-1, paragraph 1, line 8: The south plant area was originally leased to the Julius Hyman Company. Shell Chemical Company purchased Julius Hyman Company in 1952.

3. Page II-1, paragraph 3, line 5: Shell Chemical Company currently has approximately 300 permanent employees and 20 contract personnel. Approximately 120 employees are assigned to operations which operate on a 24-hour per day, seven-day per week schedule.

4. Page V-2 (Table 3), item 2 (manhole test reference No. 99): There are no connections between T-1510 and the sanitary sewer system. This has been verified by Shell personnel.

5. Page V-5, paragraph 1, line 7: Public Health Service standards for aldrin and dieldrin are one microgram per liter.

6. Page V-5, paragraph 1, line 12: Shell data indicate DBCP to be infiltrating into the sanitary sewer system between MH 119B and 117A. DBCP was produced in Building 471 and the last production on the Arsenal was in February 1976.

7. Page VI-4: As discussed in the October 17, 1979, meeting, Shell believes the cost estimates to be low by a factor of two or more.

RWV
10/18/79

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED PROC REG 141 CFR) 1-16.101

DoN AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
P00002	79AUG02		AE (Rocky Mtn. Ars.)

5. ISSUED BY — CODE W59XQG

District Engineer, Dept. of the Army
maha District, Corps of Engineers
6014 U. S. Post Office & Court House
Omaha, NE 68102

CODE XXXXXXXXXXXXXXXXXXX

Contract for:
Liquid Waste Disposal Facil.
Rocky Mtn. Ars., Colorado

7. CONTRACTOR NAME AND ADDRESS — CODE — FACILITY CODE

(Street, city, county, state, and ZIP Code)

Black & Veatch
1500 Meadow Lake Parkway
Kansas City, MO 64114

8.
☐ AMENDMENT OF SOLICITATION NO. _____
DATED _____ (See block 11)
☒ MODIFICATION OF CONTRACT/ORDER NO. ~~DACA45-79-C-0019~~
DATED 780CT17 (See block 11)
Negotiated

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

2192050 908-9218 P6700-257 S25066 RA9002950680004

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☒ This Change Order is issued pursuant to: General Provisions Clause 3

The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☐ This Supplemental Agreement is entered into pursuant to authority of _____

It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The Architect-Engineer shall provide the following additional services under paragraph 2 of Title I:

Provide necessary services required to accomplish the Sanitary Sewer Survey at Rocky Mountain Arsenal, Colorado, in accordance with Scope of Work, attached hereto and by this reference made a part hereof.

It is understood and agreed that all work under this modification shall be completed within 60 calendar days after receipt of notice to proceed and the contract price is increased by the lump sum amount of $94,694.00.

The foregoing modification of said contract is hereby accepted.

THIS MODIFICATION HAS BEEN COMPLETELY EXECUTED

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 1 COPY XXXXX TO ISSUING OFFICE

NAME OF CONTRACTOR/OFFEROR: BLACK & VEATCH

BY: _____ (Signature of person authorized to sign)

17. UNITED STATES OF AMERICA

BY: _____ (Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
HARRY L. CALLAHAN, Partner	06 Sep 79	LARRY B. FULTON, LTC, CE Dep Dist Engr for Mil Const	9/4/79

SCOPE OF WORK
Modification No. 2 to
Contract No. DACA 45-79-C-0019
Rocky Mountain Arsenal, Colorado

1. The Architect-Engineer shall provide the services required to accomplish the sanitary sewer survey at Rocky Mountain Arsenal, Colorado as detailed in the following listing of project phases.

a. Initiate Project.

Attend meeting with staff personnel from the Corps of Engineers, Omaha District, Rocky Mountain Arsenal, Shell Chemical Company and members of the project team to confirm project objectives, responsibilities, procedures, and communication network. Identify contacts within each group responsible for coordination activities. Project team members will attend indoctrination sessions presented by both Rocky Mountain Arsenal (RMA) and Shell Chemical Company (SCC) personnel. Necessary medical examinations and work clearances will be obtained at this time.

b. Collect and Review Available Data.

Collect and review available data from both RMA and SCC to include existing flow measurements and data on manhole inspections, sewer inspections (television), ground-water monitoring, sewer mapping and relevant location and elevation information.

Collect and review applicable Federal, state and local permits on pollution control regulations. Inventory specific data requirements necessary for implementation of permits.

c. Select Key Manholes.

Determine the most effective division of sewer subsystems utilizing available data to maximum extent. Determine the hydraulic capacity of proposed gaging locations. Review selection with RMA and SCC personnel.

d. Verify Sewer System Maps.

Examine existing sewer system maps for the area from the RMA Wastewater Treatment Plant to the South Plant, GB area, and Administration Building area. Determine adequacy of available system maps.

e. Install Flow Monitoring Devices.

Install flow monitoring devices in all key manholes. Inspect manholes during placement. Report abnormal or potentially dangerous conditions (ground-water leakage, broken pipes, etc.) to RIA immediately.

f. Obtain Sewer Flow Data.

Obtain sewer flow data from key manholes and the wastewater treatment plant influent over a sufficient period of time to enable definition of both dry and wet weather flow conditions, (90 day maximum). Extract and review data periodically to enable relocation of flow devices for proper evaluation o. infiltration/inflow occurrences. Monitor ground-water levels. Upon completion of data collection, remove flow measuring devices and compute flows.

g. Estimate Infiltration/Inflow and Exfiltration Rates.

Utilize preliminary data from flow measuring efforts and historical data to provide a general delineation of areas contributing to infiltration/inflow and/or exfiltration. Evaluate wastewater flow hydrographs in conjunction with rainfall events, ground-water levels and possible local flooding. Determine the magnitude and duration of wastewater flow responses to rainfall events. Utilizing available information and following the procedures, when applicable, set forth in the EPA publication "Handbook for Sewer System Evaluation and Rehabilitation" (1975), calculate total annual infiltration/inflow/exfiltration for select locations in the system. Separate out, when data permits, the infiltration portion of infiltration/inflow by comparing theoretical base sanitary flow with average dry weather flow.

h. Formulate Systematic Procedures.

Formulate and review with COE, RMS and SCC procedure for inspecting sewer system.

i. Physically Survey Sewers Above Ground.

Verify and update system maps by land survey method. Locate all manholes and identify with numbers manholes for proper future reference. Search for problem areas of inflow such as low-lying areas subject to flooding or ponding, creek crossings, and areas where contaminated sewer is in proximity to sanitary sewer. Identify potential for vehicular access such as hydraulic jet cleaner to minimize future inconveniences and maximize footage to be cleaned from one point.

j. Physically Inspect Manholes Internally.

Evaluate the structural condition of manholes. Indicate groundwater leakage in manholes. Report severe conditions or leakage to individuals identified in a. (above). Determine visual evidence of or actual sources of infiltration.

k. Identify Specific Sources of Infiltration/Inflow and Exfiltration.

Utilize the data of j. (above) to identify specific sources of infiltration/inflow and exfiltration.

l. Update Existing Sewer System.

Utilize data from d. and i. (above) to correct or supplement existing sewer system maps.

m. Perform Smoke Testing.

Perform smoke testing for sanitary sewer from wastewater treatment plant to and within the following areas:

1) GB
2) Administration
3) South Plants

n. Perform Water Quality Sampling.

Perform selective water quality sampling to identify specific source areas for DBCP, aldrin, DIMP, endrin as specified by the COE/Omaha. Laboratory work to be provided by RMA.

o. Summarize Results of Laboratory Analysis.

Summarize laboratory results provided by the RMA performed on water quality samples collected during this project.

2. Prepare "Report Memorandum" to include findings, determinations and recommendations, and attend review conference in the Omaha District Office.

[illegible] [illegible] [illegible]

516-921-6060

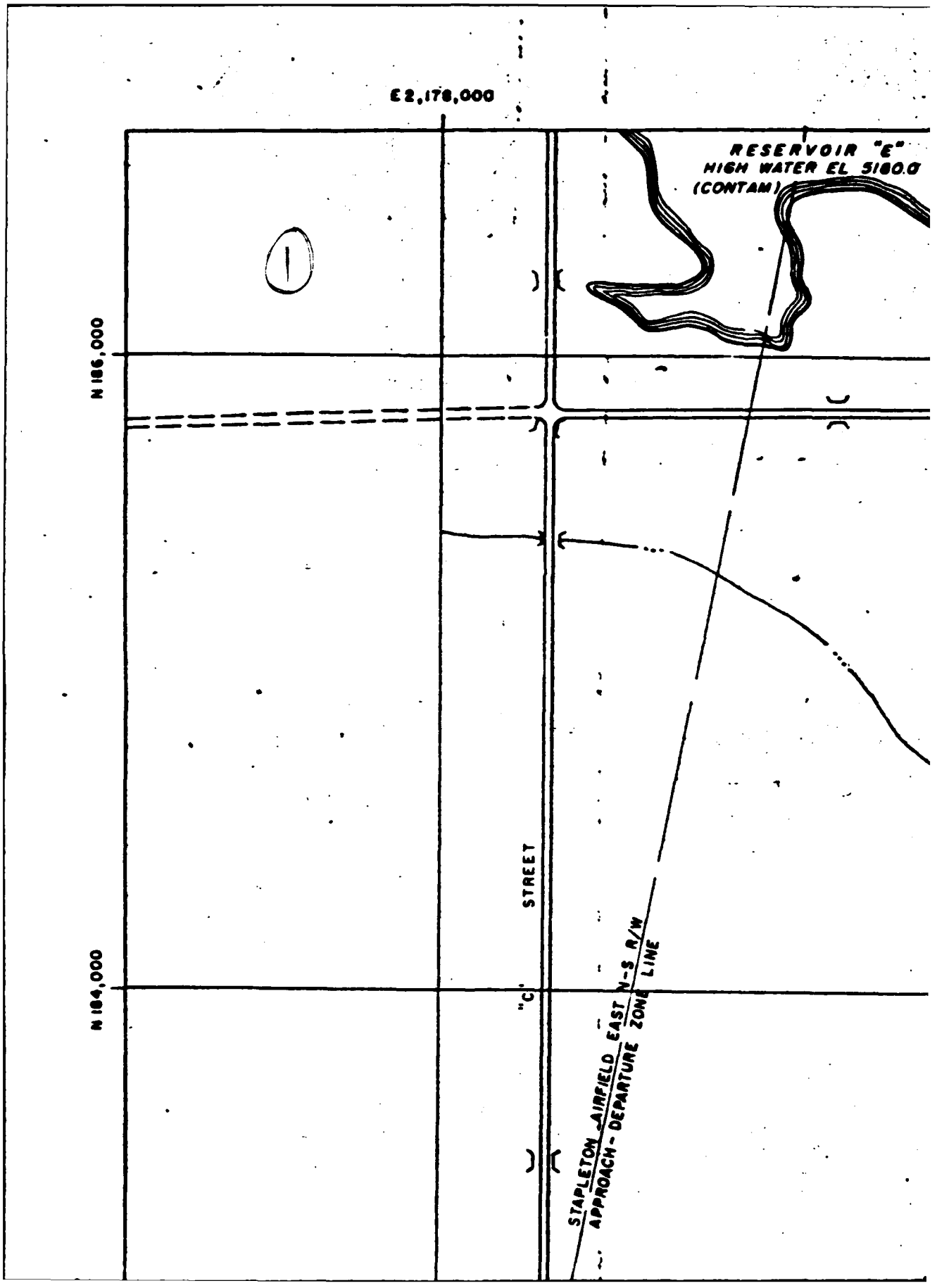
CO ~~[illegible]~~ 470

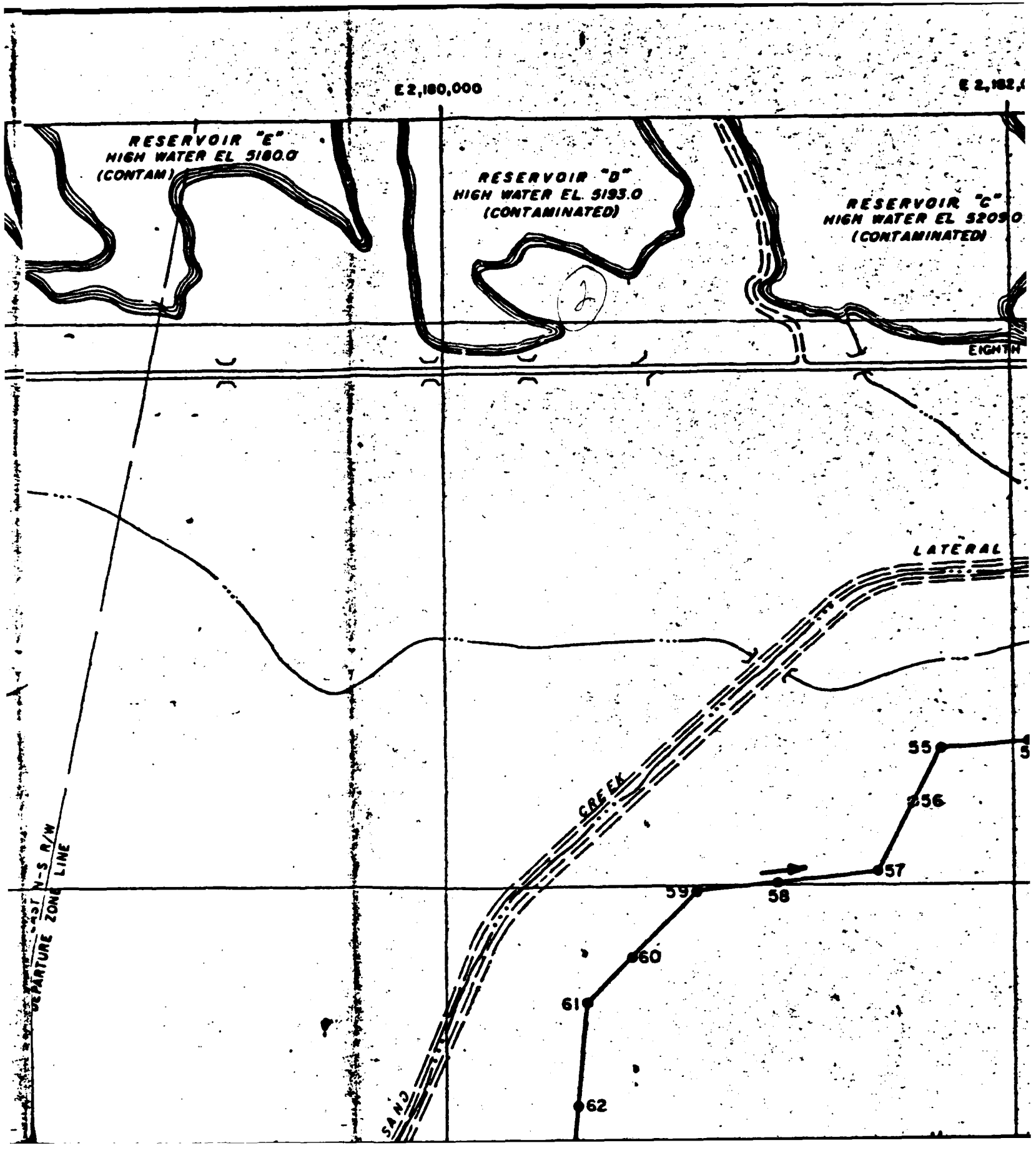
[illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible]

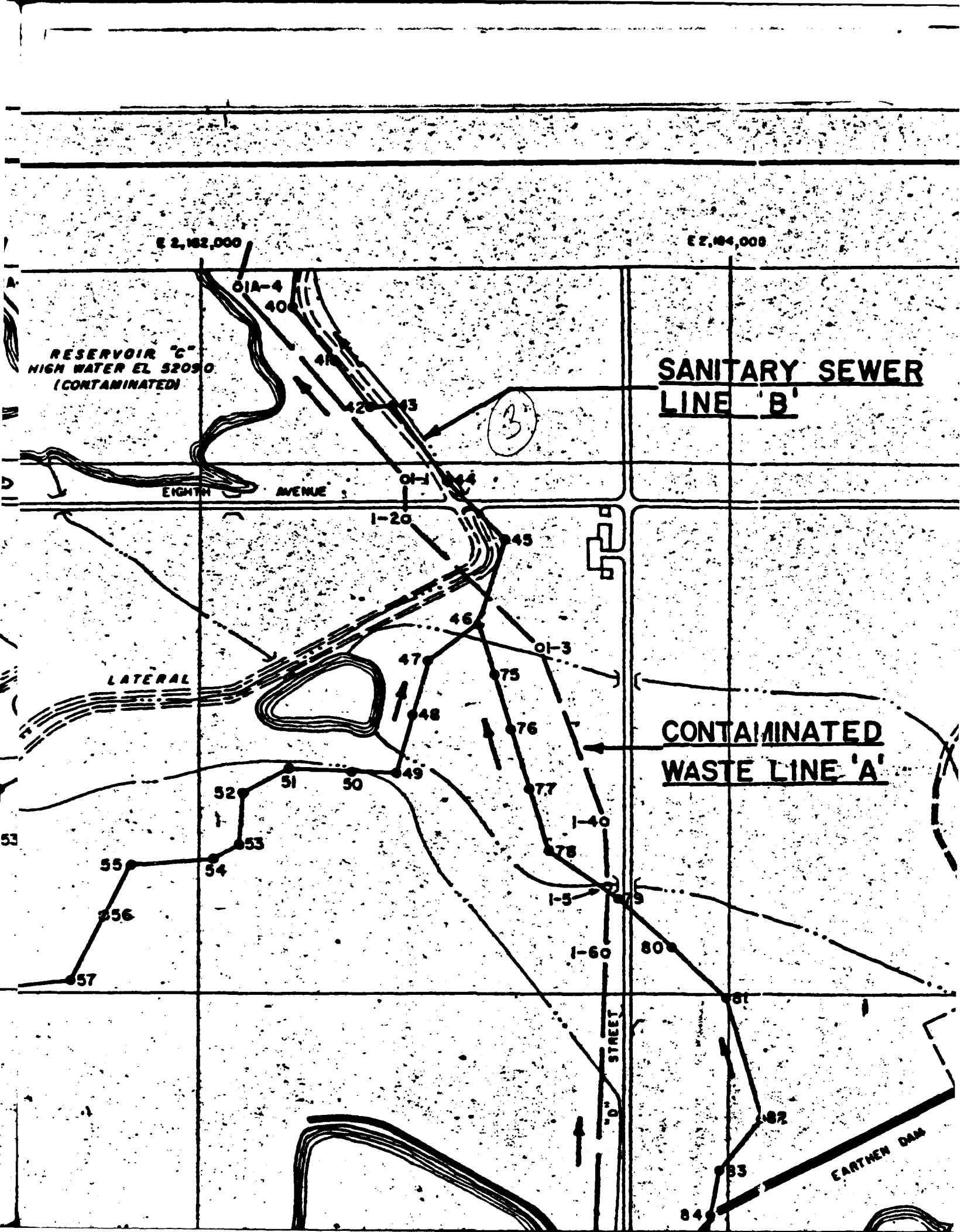
Drawing 7164-2005 Sept 17 1942

[illegible]	Surf.	Inv
10	5173.30	5170.38
11	5173.76	5170.36
3	5177.57	5171.67
14	5181.87	5172.77
15	5181.98	5173.78
16	5182.09	5175.89
17	5184.70	5177.96
18	5186.70	5179.97
19	5190.70	5184.04
20	5193.30	5186.38
21	5197.05	5188.92
22	5197.35	5190.65
23	5199.15	5192.57
24	5201.45	5194.14
25	5203.53	5195.70
26	5205.27	5196.26
27	5202.96	5196.78
28	5204.18	5197.25
29	5205.60	5198.90
30	5207.40	5200.48
31	5206.80	5201.76
31-A	5209.95	5203.12

孔#	high.	low
32	5205.45	5204.09
33	5207.35	5206.03
34	5213.27	5201.94
35	5220.46	5207.95
98	5264.85	5252.14


E 2,178,000
RESERVOIR "E"
HIGH WATER EL 5180.0
(CONTAM)
1
N 186,000
N 184,000
STREET
"C"
STAPLETON AIRFIELD EAST N-S R/W
APPROACH - DEPARTURE ZONE LINE


E 2,180,000
E 2,182,
RESERVOIR "E"
HIGH WATER EL 5180.0
(CONTAM)
RESERVOIR "D"
HIGH WATER EL. 5193.0
(CONTAMINATED)
RESERVOIR "C"
HIGH WATER EL 5205.0
(CONTAMINATED)
EIGHTH
LATERAL
CREEK
SAN
55
56
57
58
59
60
61
62
DEPARTURE ZONE LINE
EAST N-S R/W


E 2,182,000
E 2,184,000
RESERVOIR "C"
HIGH WATER EL 5209.0
(CONTAMINATED)
SANITARY SEWER
LINE 'B'
EIGHTH AVENUE
LATERAL
CONTAMINATED
WASTE LINE 'A'
"D" STREET
EARTHEN DAM
01A-4
01-1
01-2
01-3
1-20
1-40
1-5
1-60
40
41
42
43
44
45
46
47
48
49
50
51
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53
54
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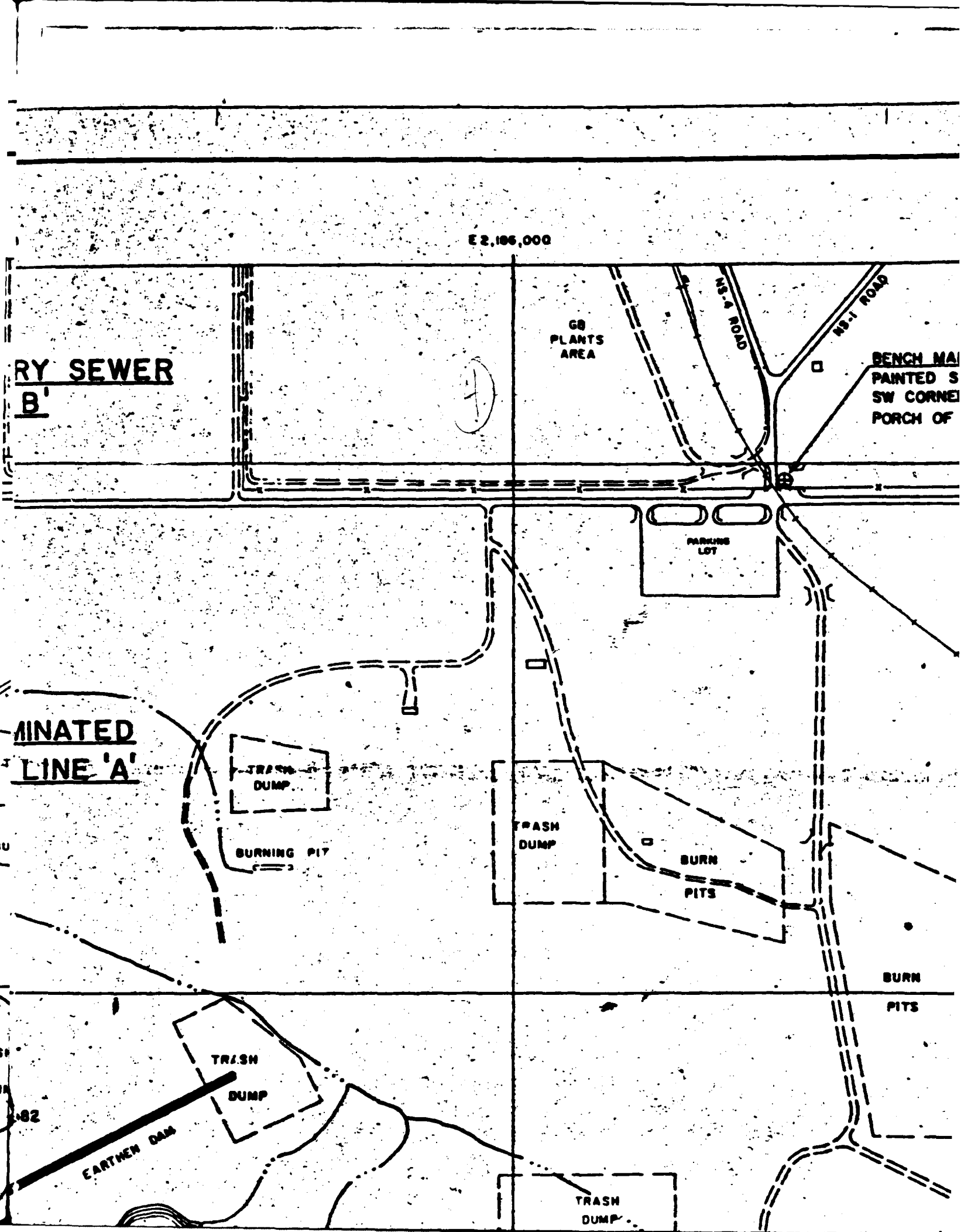
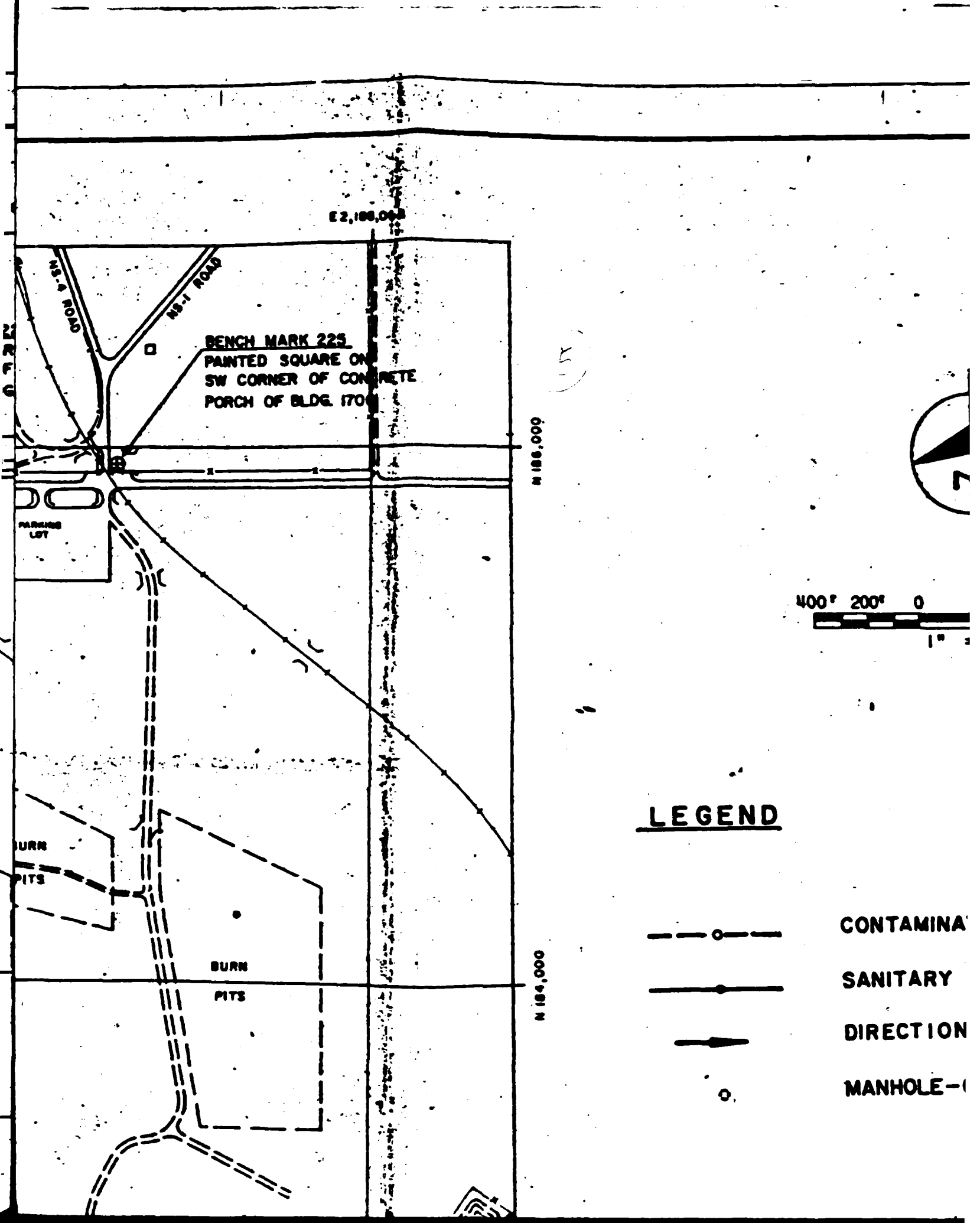
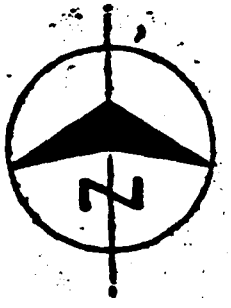
56
57
75
76
77
78
79
80
81
82
83
84


E 2,186,000
RY SEWER
B'
GB
PLANTS
AREA
NS-4 ROAD
NS-1 ROAD
BENCH MA
PAINTED S
SW CORNE
PORCH OF
PARKING
LOT
MINATED
LINE 'A'
TRASH
DUMP
BURNING PIT
TRASH
DUMP
BURN
PITS
BURN
PITS
TRASH
DUMP
EARTHEN DAM
TRASH
DUMP


E 2,186,000
NS-4 ROAD
NS-1 ROAD
BENCH MARK 225
PAINTED SQUARE ON
SW CORNER OF CONCRETE
PORCH OF BLDG. 1706
N 186,000
PARKING LOT
400' 200' 0
1"
LEGEND
CONTAMINA
SANITARY
DIRECTION
MANHOLE-(
BURN
PITS
BURN
PITS
N 184,000



(6)

400' 200' 0 400' 800'

1" = 400'

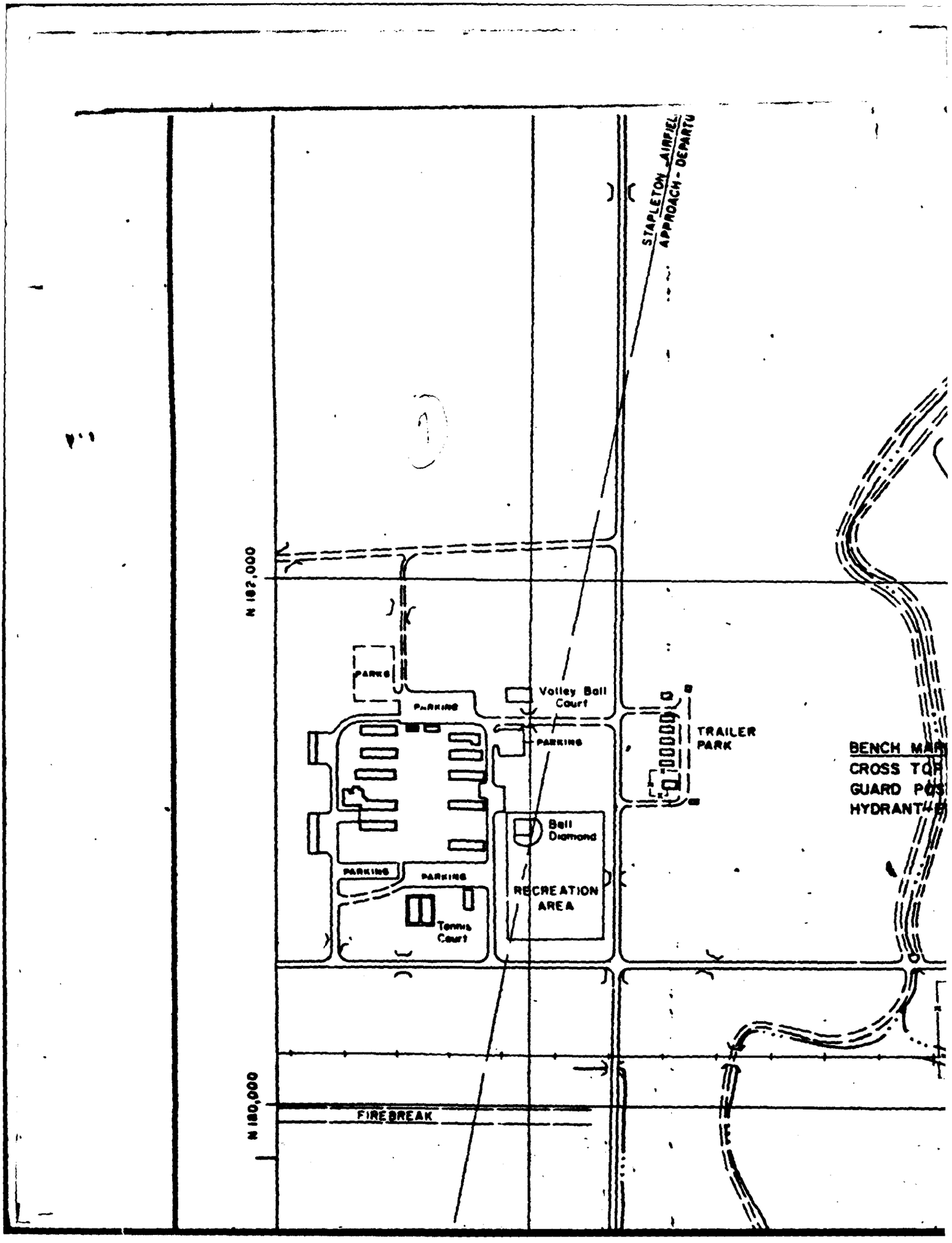
GEND

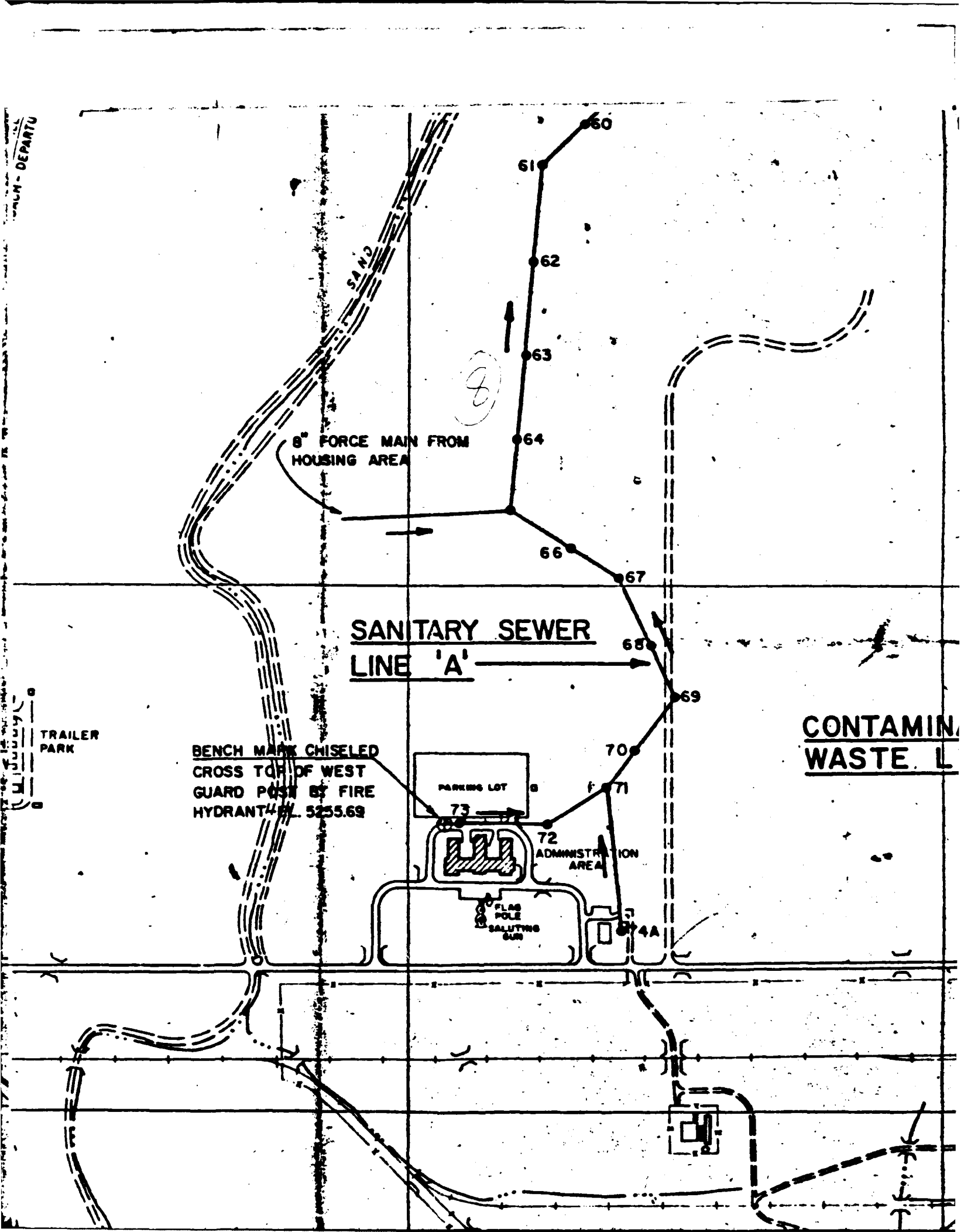
CONTAMINATED WASTE LINE & MANHOLE

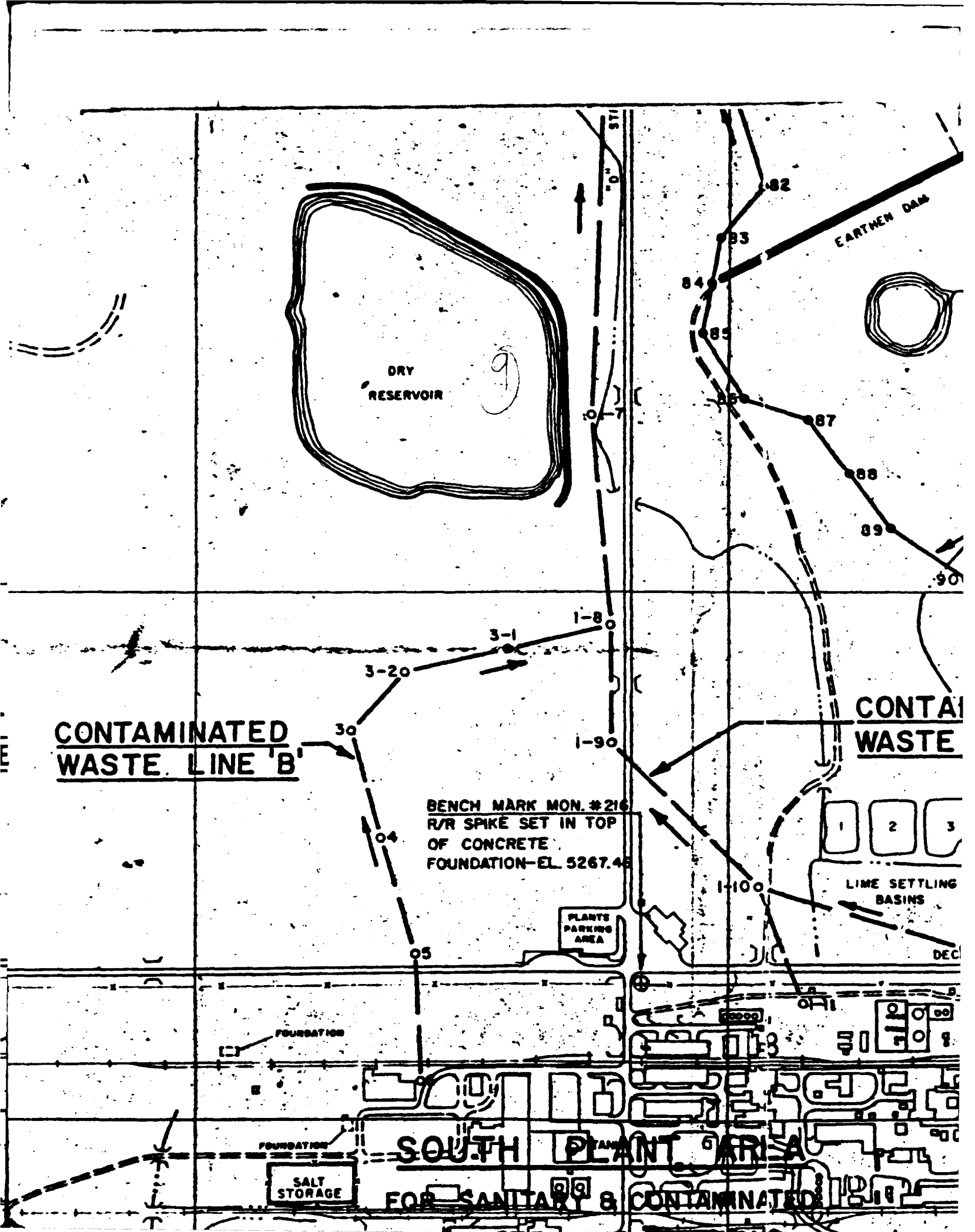
SANITARY SEWER LINE & MANHOLE

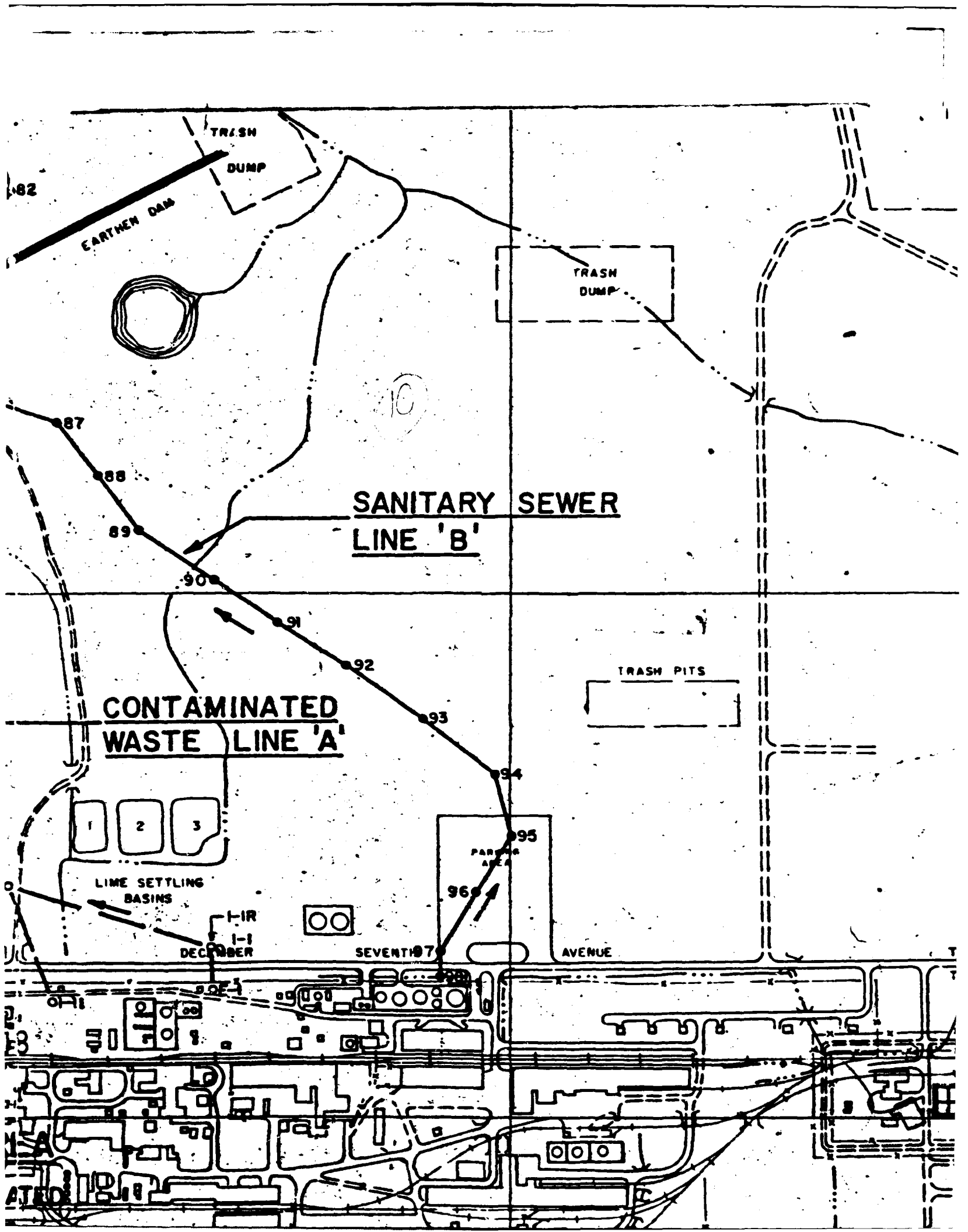
DIRECTION OF FLOW

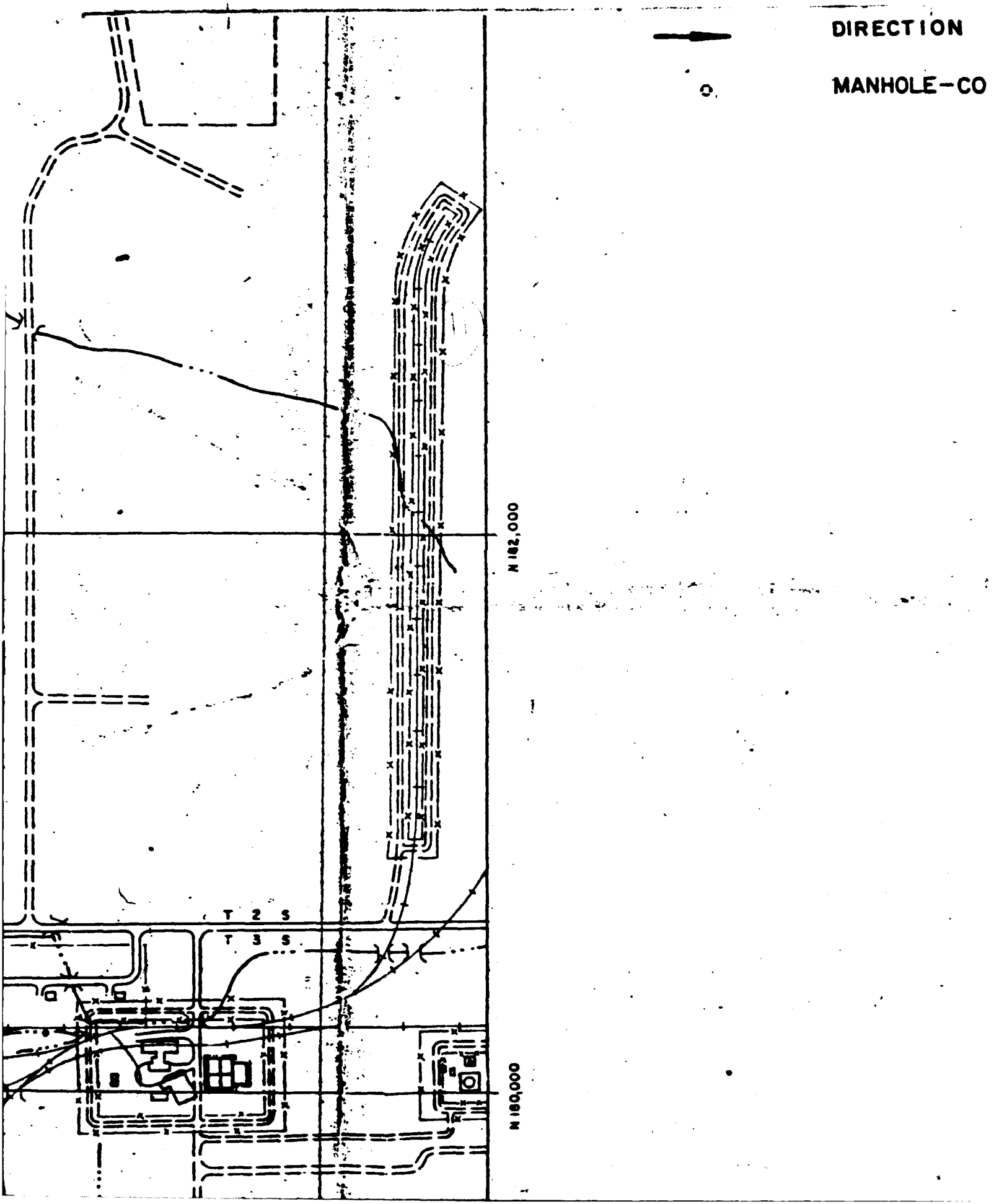
MANHOLE-COULD NOT FIELD LOCATE


STAPLETON AIRFIEL
APPROACH - DEPARTU
N 182,000
N 180,000
PARKING
PARKING
Volley Ball Court
PARKING
TRAILER PARK
Ball Diamond
RECREATION AREA
PARKING
PARKING
Tennis Court
FIRE BREAK
BENCH MA
CROSS TO
GUARD PO
HYDRANT


60
61
62
63
64
66
67
68
69
70
71
72
73
74A
SAND
8" FORCE MAIN FROM HOUSING AREA
SANITARY SEWER LINE 'A'
TRAILER PARK
BENCH MARK CHISELED CROSS TOP OF WEST GUARD POST BY FIRE HYDRANT EL. 5255.69
PARKING LOT
ADMINISTRATION AREA
FLAG POLE
SALUTING GUN
CONTAMIN
WASTE L


DRY
RESERVOIR
EARTHEN DAM
82
83
84
85
86
87
88
89
90
1-8
3-1
3-2
30
1-9
04
05
1-10
CONTAMINATED
WASTE LINE 'B'
CONTA
WASTE
BENCH MARK MON. #216
R/R SPIKE SET IN TOP
OF CONCRETE
FOUNDATION-EL. 5267.46
LIME SETTLING
BASINS
PLANTS
PARKING
AREA
FOUNDATION
FOUNDATION
SALT
STORAGE
SOUTH PLANT AREA
FOR SANITARY & CONTAMINATED

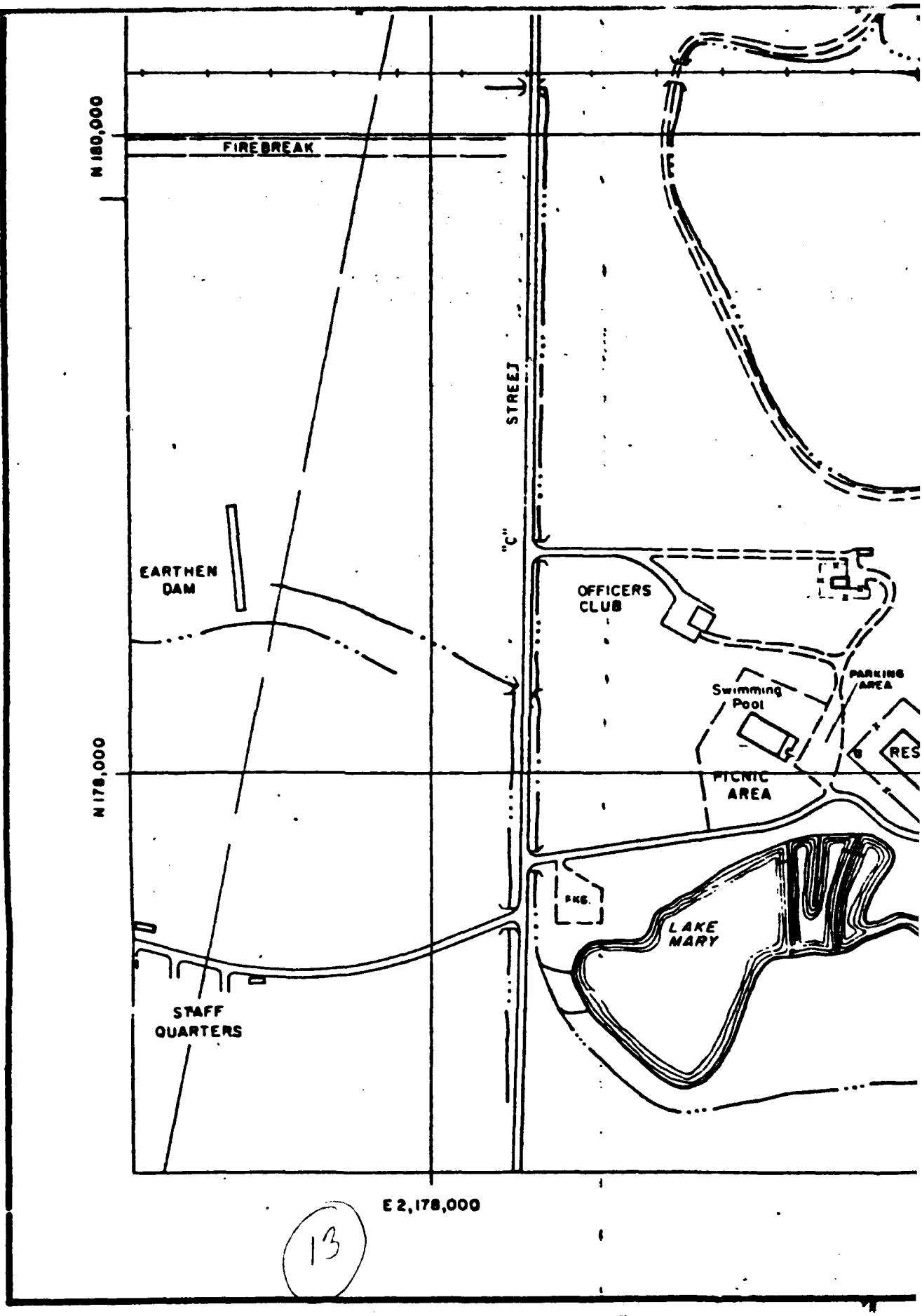

TRASH DUMP
EARTHEN DAM
TRASH DUMP
87
88
89
90
91
92
93
94
95
96
97
SANITARY SEWER LINE 'B'
CONTAMINATED WASTE LINE 'A'
TRASH PITS
1
2
3
LIME SETTLING BASINS
SEVENTH
AVENUE

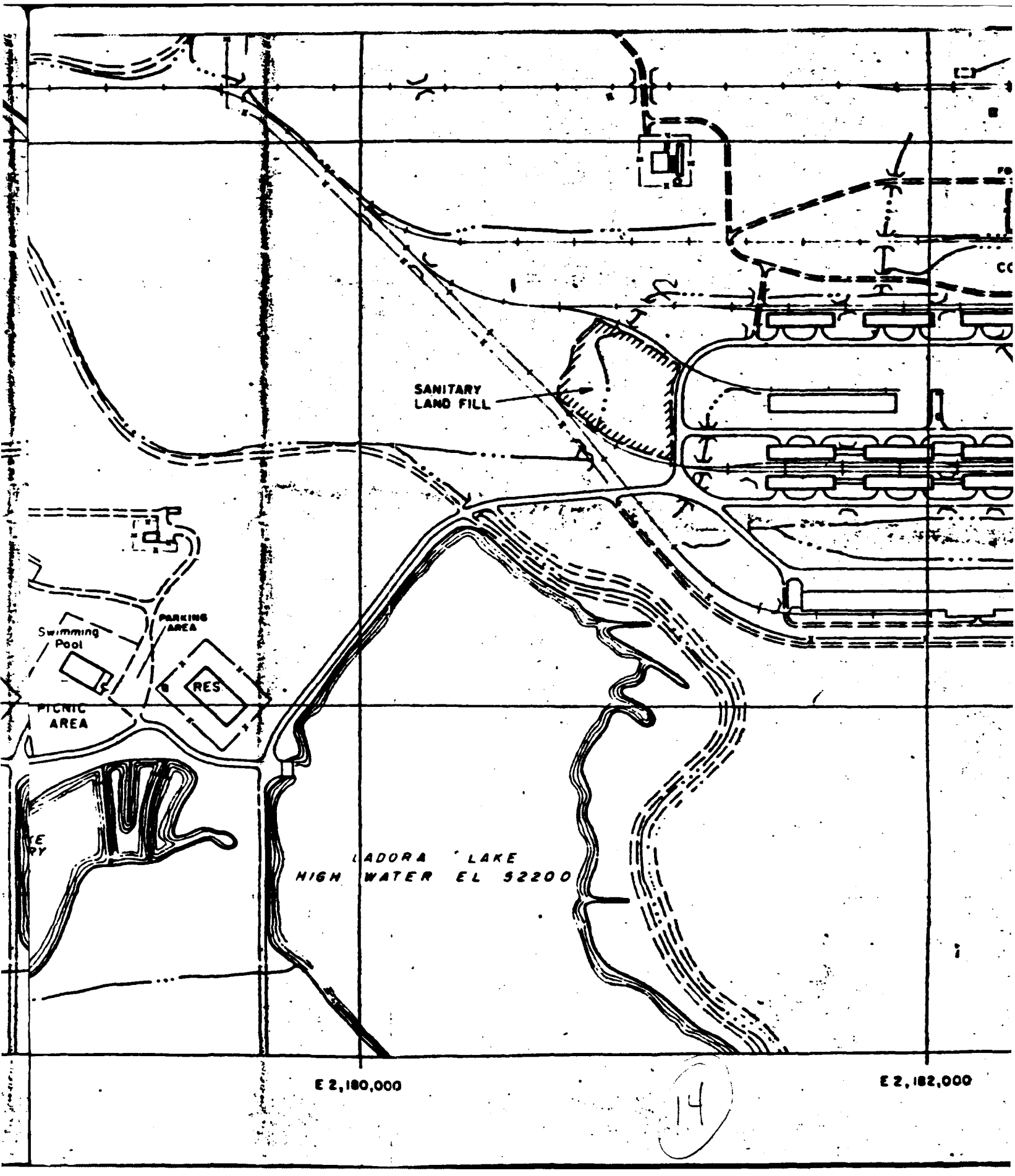

DIRECTION
MANHOLE—CO
N 182,000
T 2 S
T 3 S
N 180,000

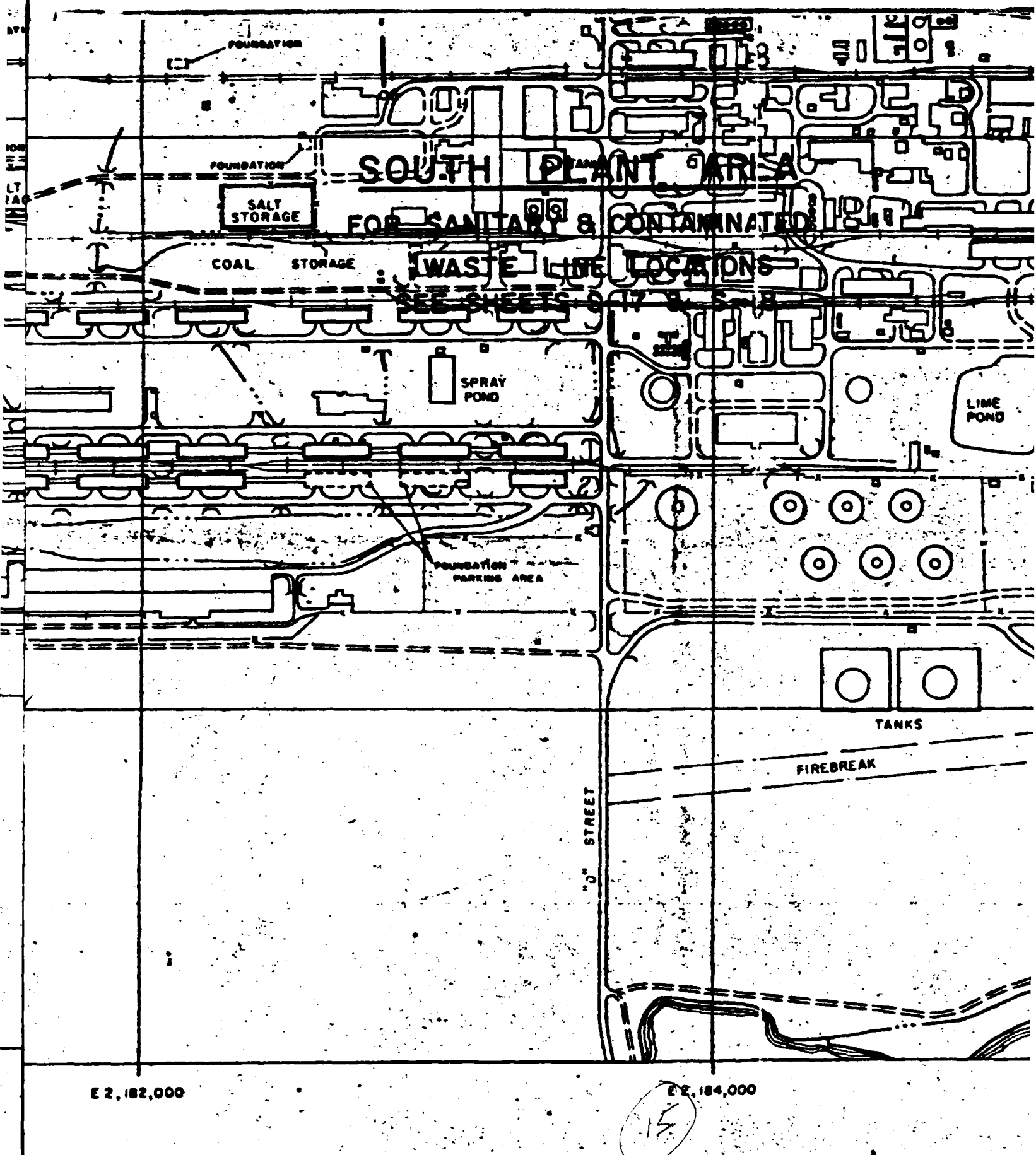
DIRECTION OF FLOW

MANHOLE-COULD NOT FIELD LOCATE

12


N 180,000
FIREBREAK
STREET
"C"
EARTHEN DAM
OFFICERS CLUB
PARKING AREA
Swimming Pool
RES
N 178,000
PICNIC AREA
PKG.
LAKE MARY
STAFF QUARTERS
E 2,178,000


SANITARY
LAND FILL
Swimming
Pool
PARKING
AREA
RES
PICNIC
AREA
LADORA LAKE
HIGH WATER EL 92200
E 2,180,000
E 2,182,000



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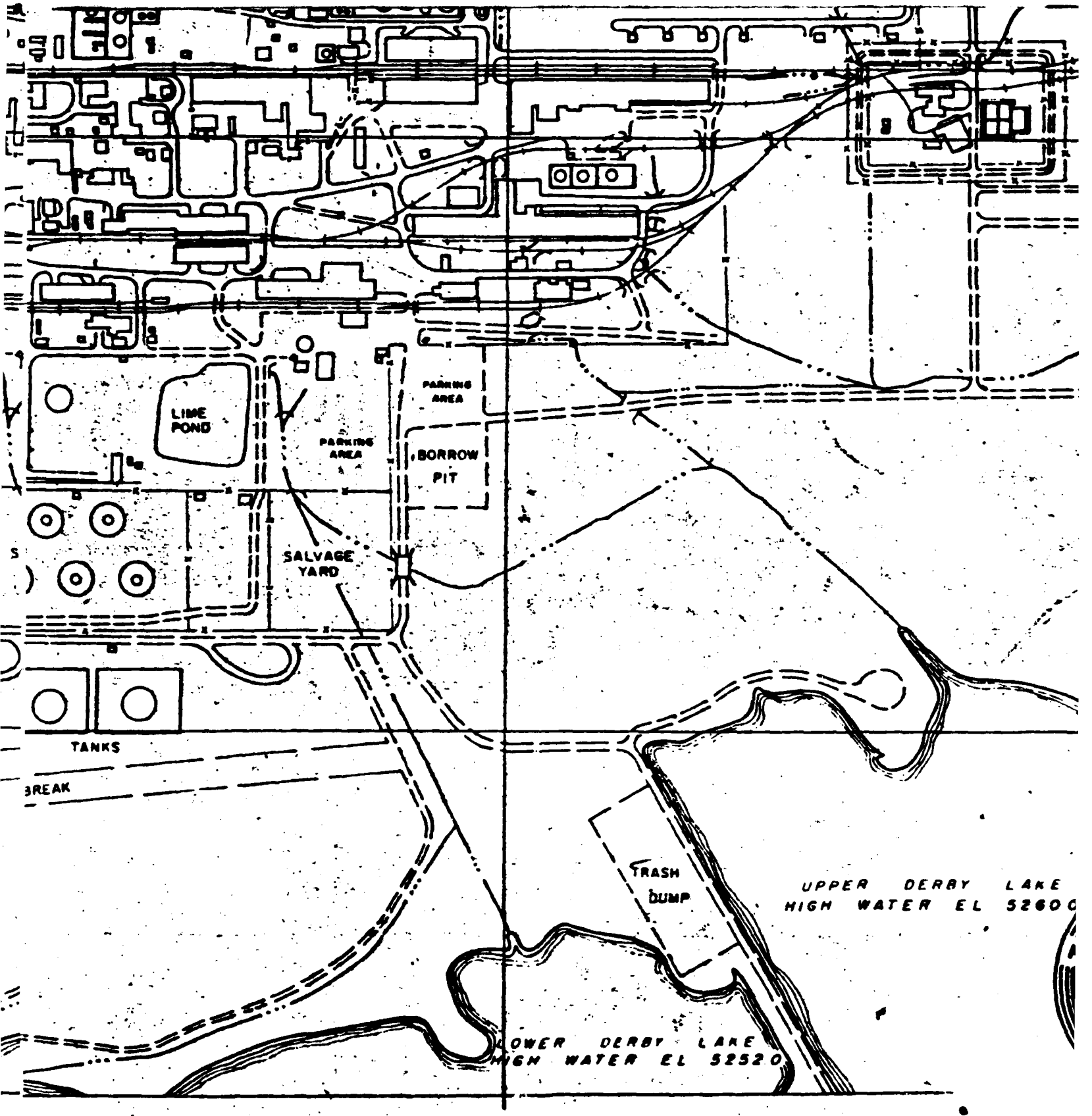


(16)

THIS PLAN ACCOMPANIES DA
DACA 45 7 CO MODI

DATE	DESCRIPTION

REVISIONS

U. S. AR

DESIGNED BY:

DRAWN BY:

CHECKED BY:

SUBMITTED BY:

ARCHITECT-ENGINEER

RECOMMENDED:

CHIEF, DESIGN BRANCH

ROCKY MOUNTAIN ARSENAL

ARMY POLLUTION AI
SEWERAGE SYS

AREA F

SHEET I

APPROVED:

CHIEF, ENGINEER DIVISION

APPROVED:

COL. C. E. DISTRICT ENGINEER

SCALE: AS SHOW

SHEET

ACCOMPANIES CONTRACT No.

CO MODIFICATION No.

DESCRIPTION	MADE	APPR'D

REVISIONS

U. S. ARMY ENGINEER DISTRICT
OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO

ARMY POLLUTION ABATEMENT PROGRAM
SEWERAGE SYSTEM SURVEY

AREA PLAN
SHEET 1 OF 2

ED BY:
BY:
D BY:
ED BY:
ECT ENGINEER
NEER:
DESIGN BRANCH

APPROVED:
CHIEF, ENGINEER DIVISION

DATE:
28 SEPT. 1979

SCALE: AS SHOWN

SPEC. NO.
DACA45

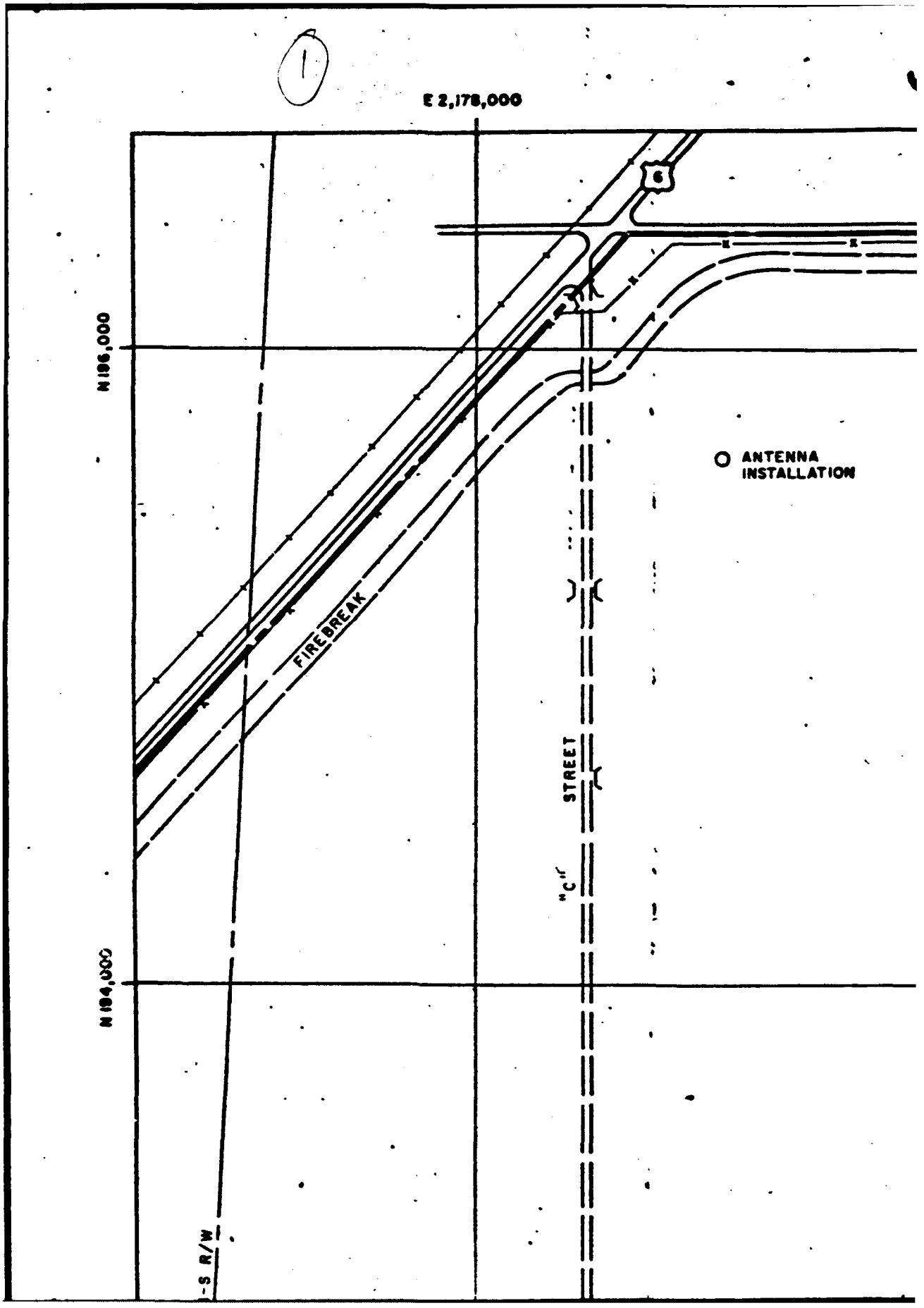
DRAWING NUMBER
S-1

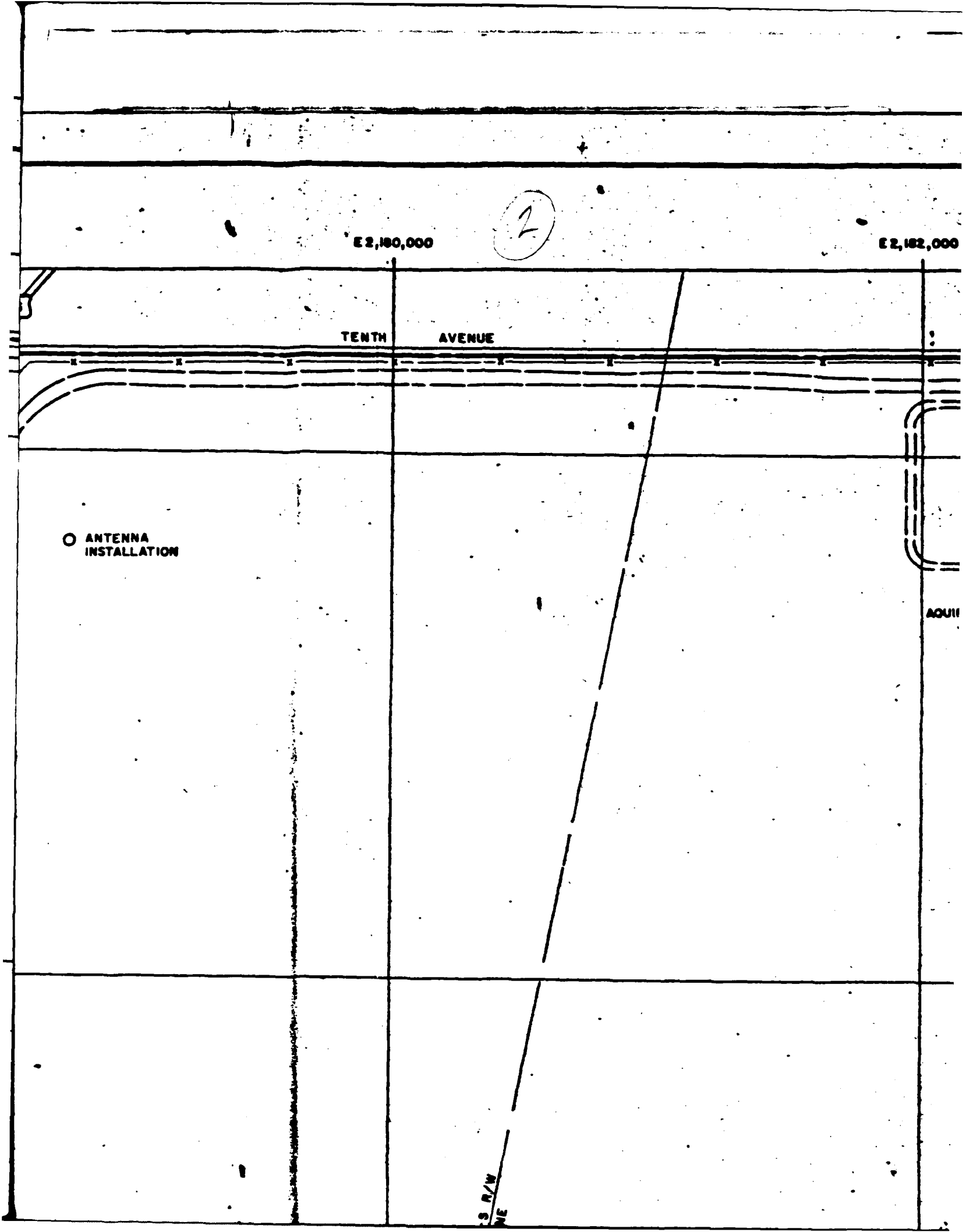
COL. C. E. DISTRICT ENGINEER

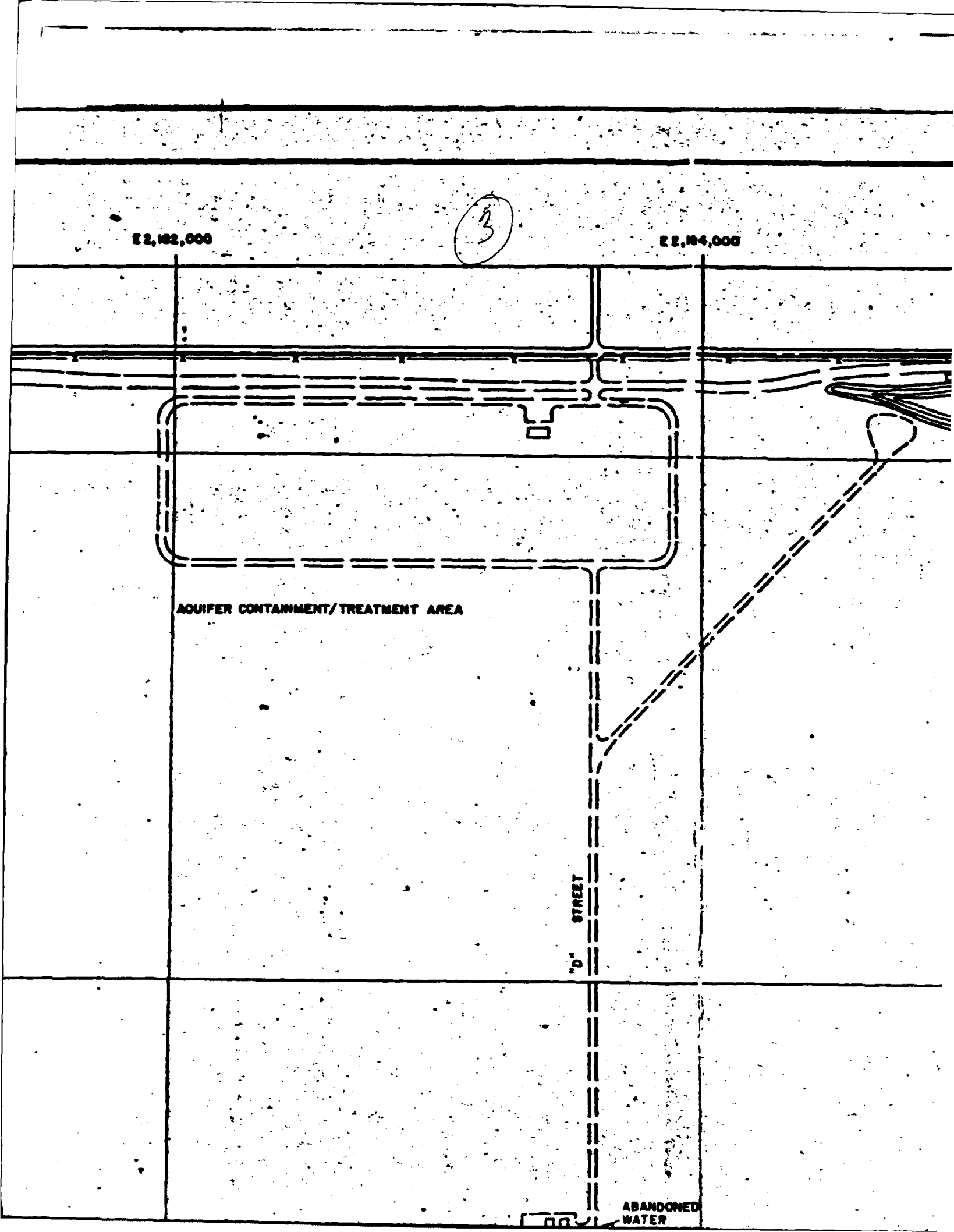
SHEET

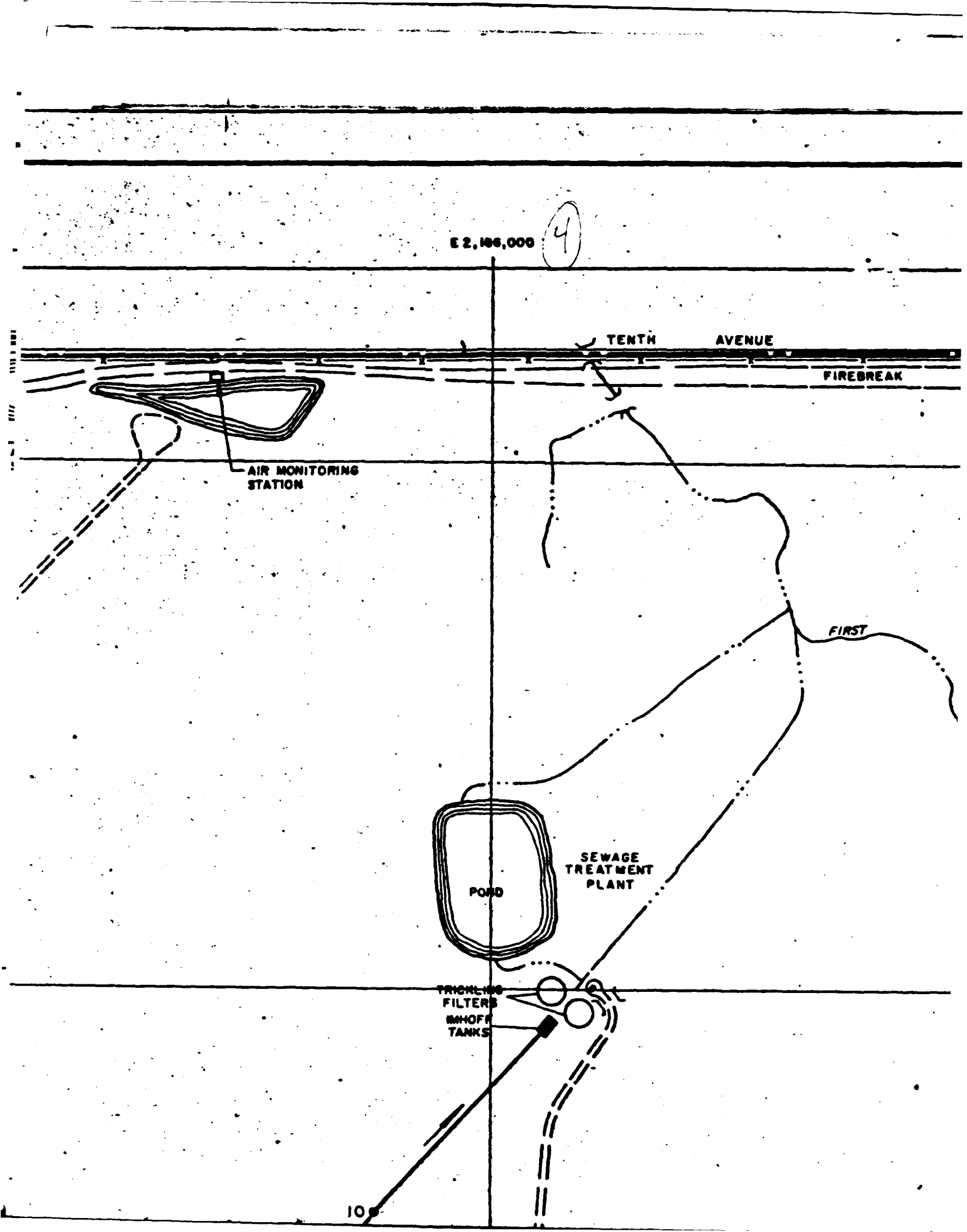
812606R35
MAP ENCLOSURE
FOR ORIGINAL
(4 SHEETS TOTAL)

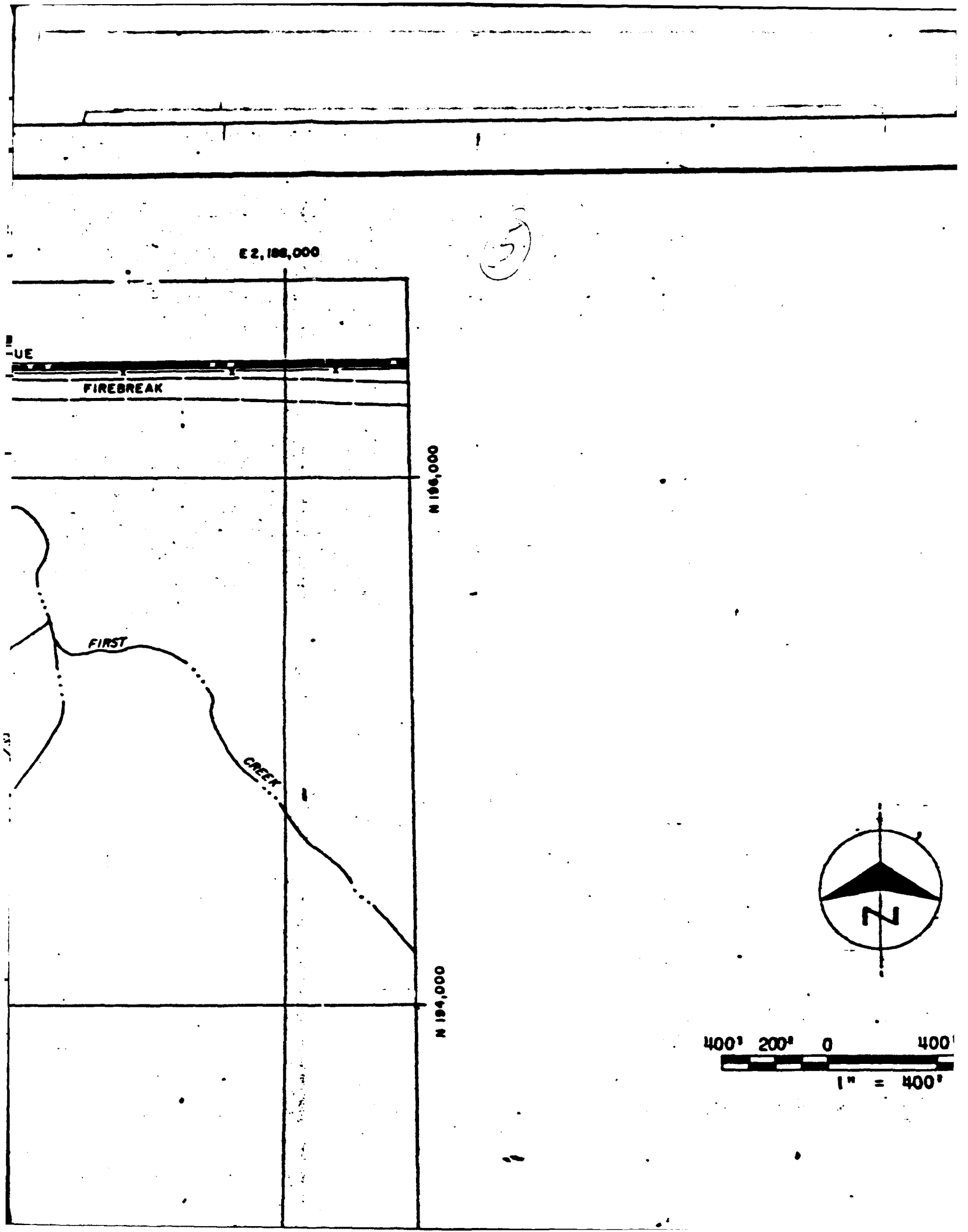
U.S. GOVERNMENT PRINTING OFFICE : 19 : 1978-


E 2,178,000
N 196,000
N 194,000
ANTENNA INSTALLATION
FIREBREAK
STREET
"C"
-S R/W

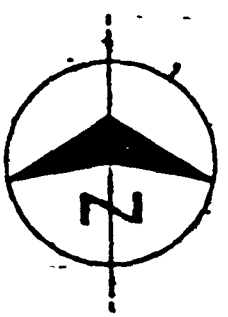

E 2,180,000
2
E 2,182,000
TENTH AVENUE
O ANTENNA INSTALLATION
AQUI
S R/W
NE


E 2,182,000
3
E 2,184,000
AQUIFER CONTAINMENT/TREATMENT AREA
"D" STREET
ABANDONED
WATER


E 2,186,000
4
TENTH AVENUE
FIREBREAK
AIR MONITORING STATION
FIRST
SEWAGE TREATMENT PLANT
POND
TRICKLING FILTERS
IMHOFF TANKS
10

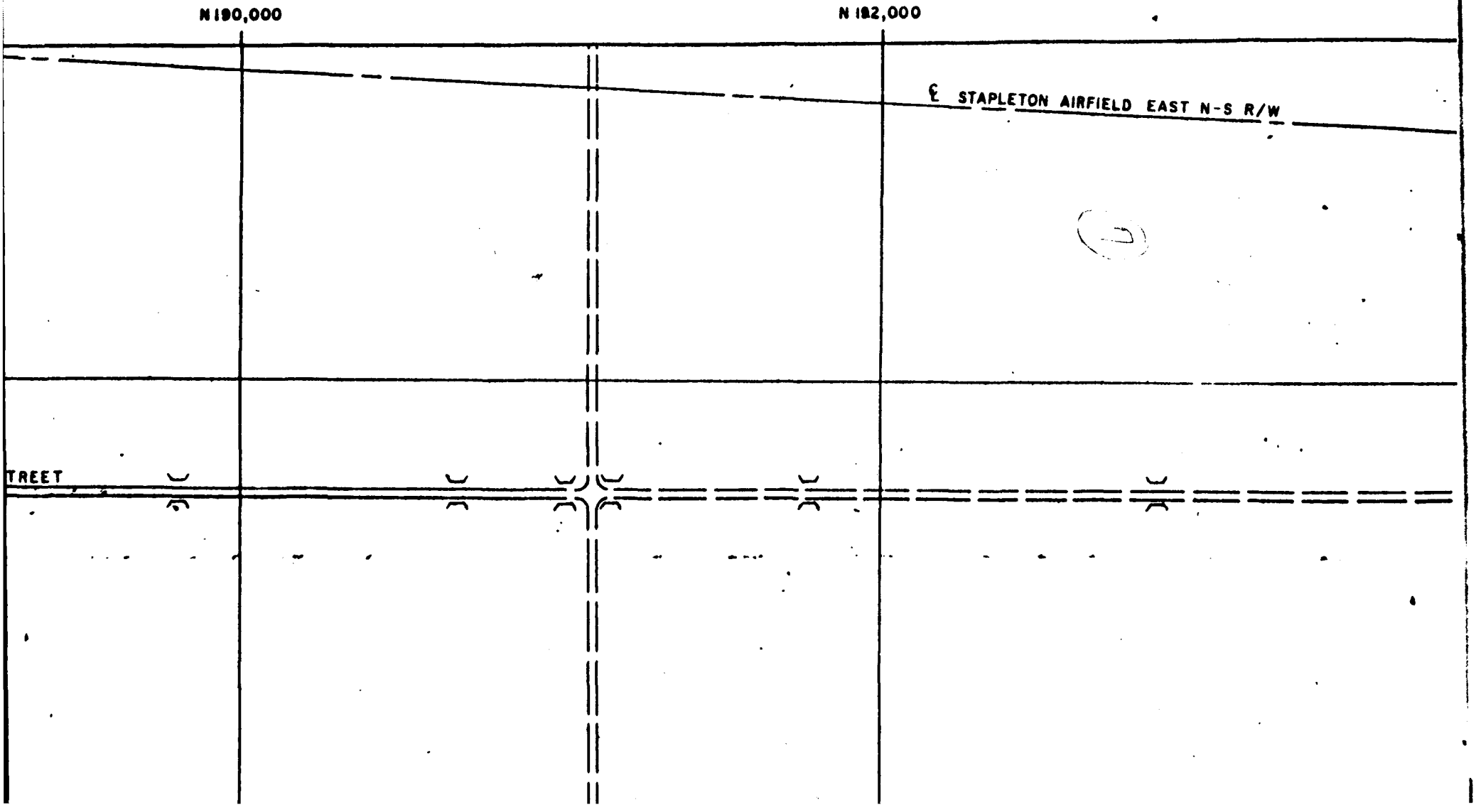

E 2,188,000
UE
FIREBREAK
N 188,000
FIRST
CREEK
N
400' 200' 0 400'
1" = 400'

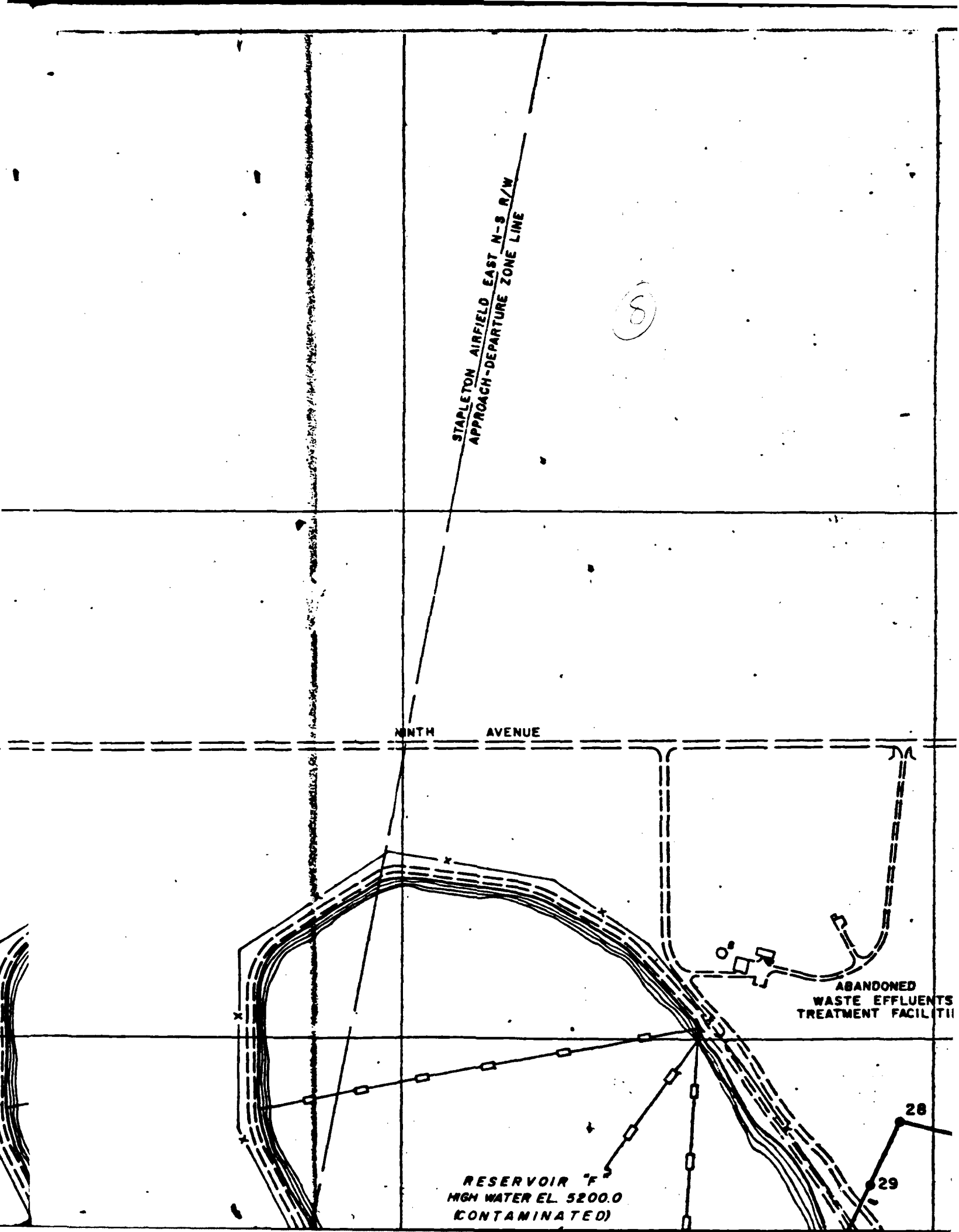
6

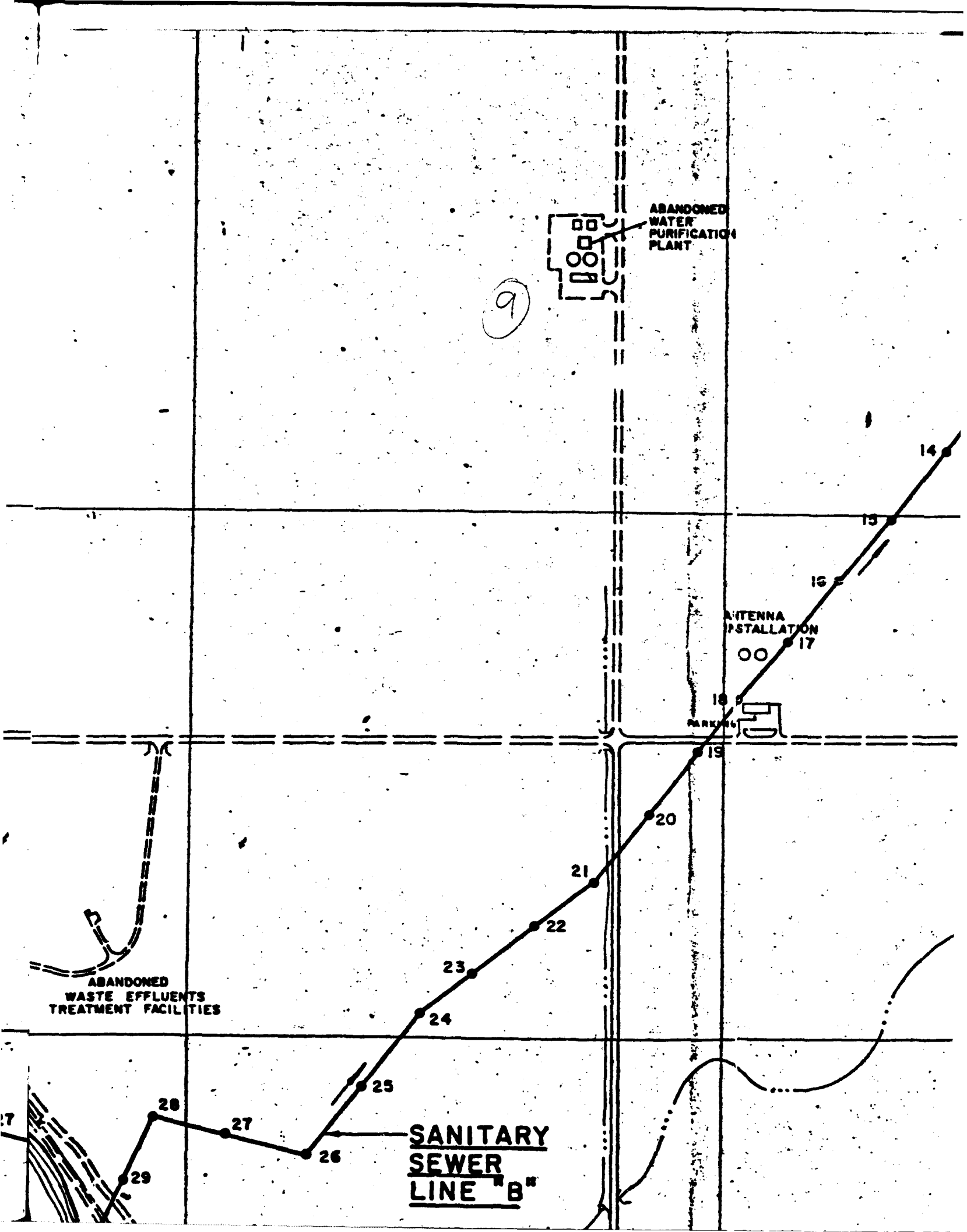


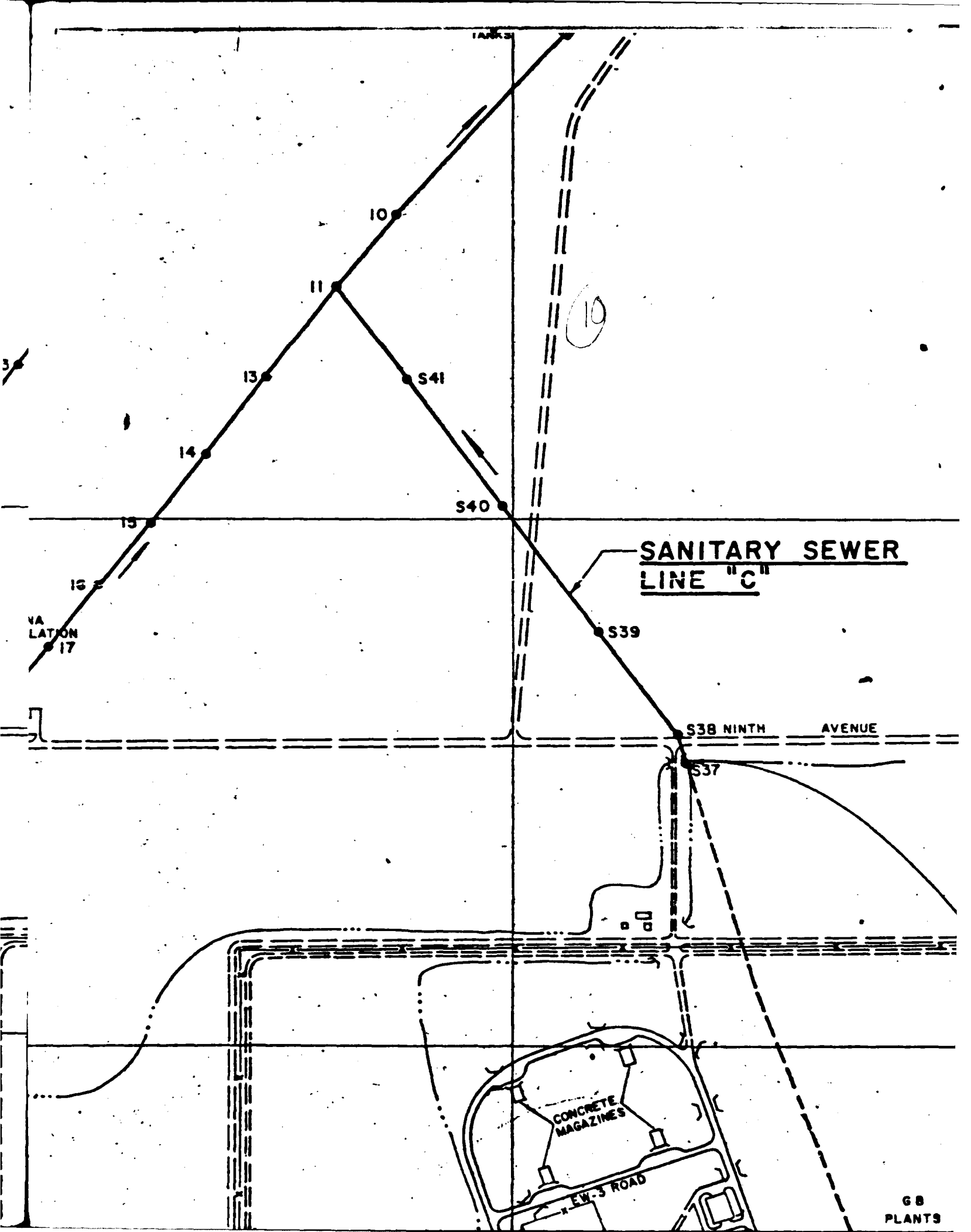
400' 200' 0 400' 800'

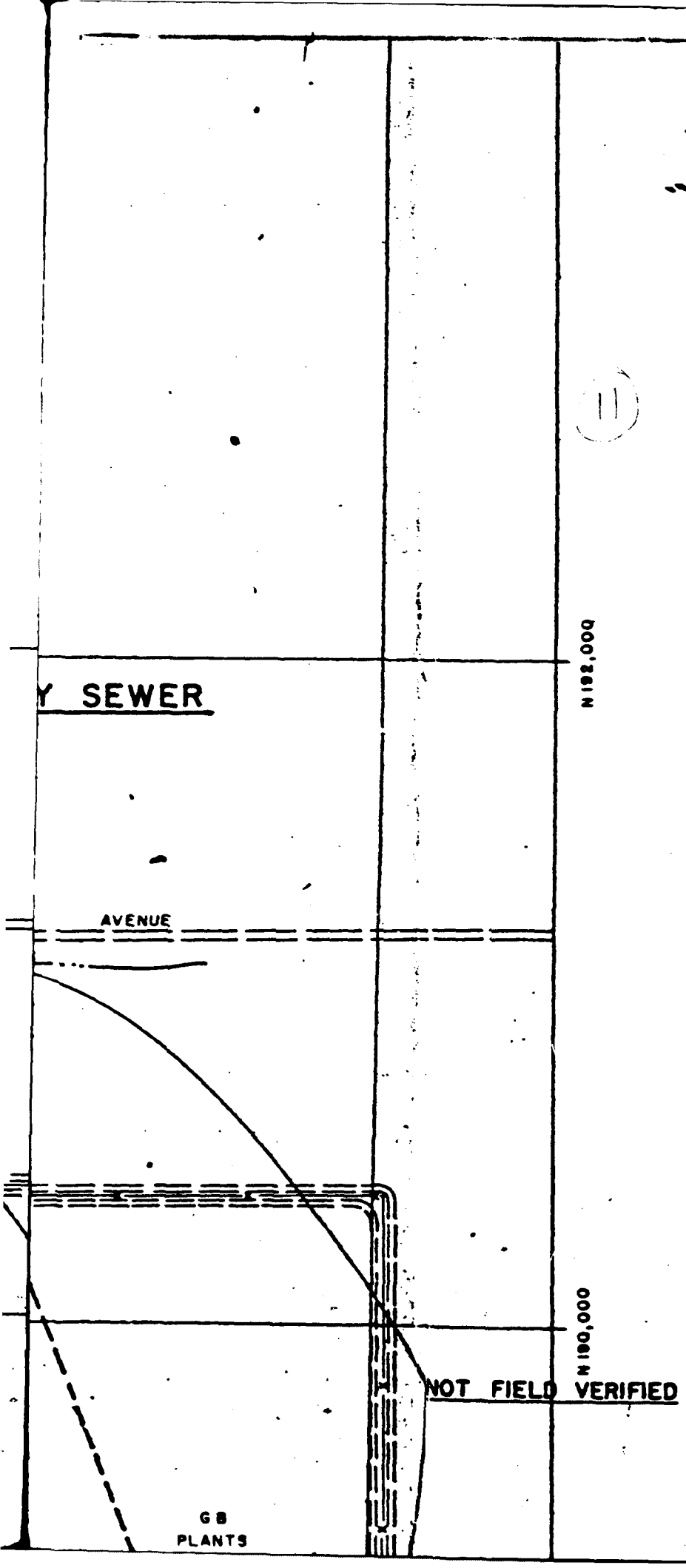
1" = 400'


N 190,000
N 182,000
℄ STAPLETON AIRFIELD EAST N-S R/W
TREET

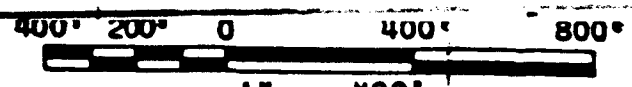

STAPLETON AIRFIELD EAST N-3 R/W
APPROACH-DEPARTURE ZONE LINE
NINTH AVENUE
ABANDONED
WASTE EFFLUENTS
TREATMENT FACILITI
RESERVOIR "F"
HIGH WATER EL. 5200.0
(CONTAMINATED)
28
29


ABANDONED
WATER
PURIFICATION
PLANT
9
14
13
12
ANTENNA
INSTALLATION
17
18
PARKING
19
20
21
22
23
24
25
26
27
28
29
ABANDONED
WASTE EFFLUENTS
TREATMENT FACILITIES
SANITARY
SEWER
LINE "B"

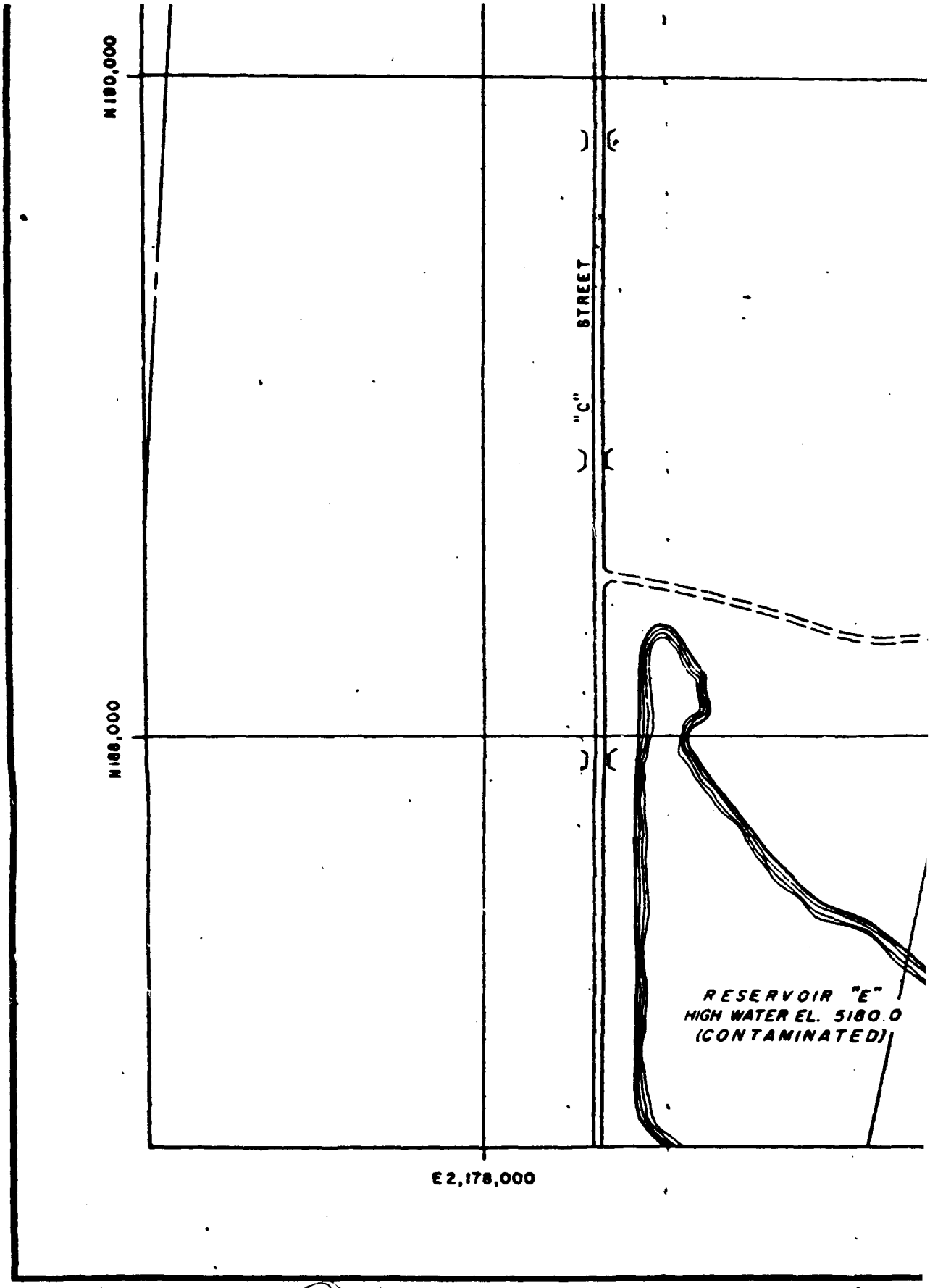

10
11
13
14
15
16
17
S41
S40
S39
S38 NINTH AVENUE
S37
SANITARY SEWER
LINE "C"
CONCRETE
MAGAZINES
E.W.-3 ROAD
GB
PLANTS

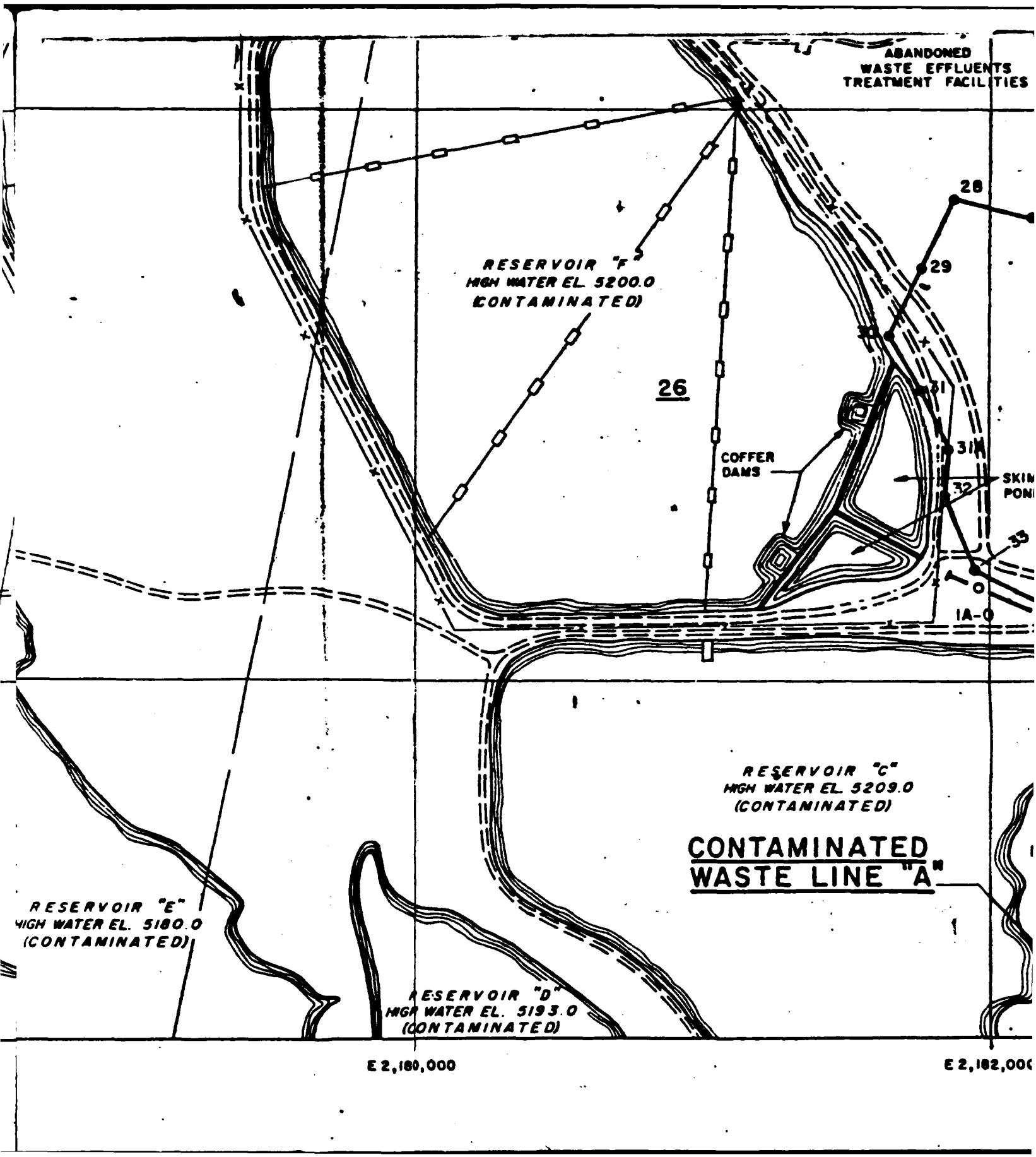


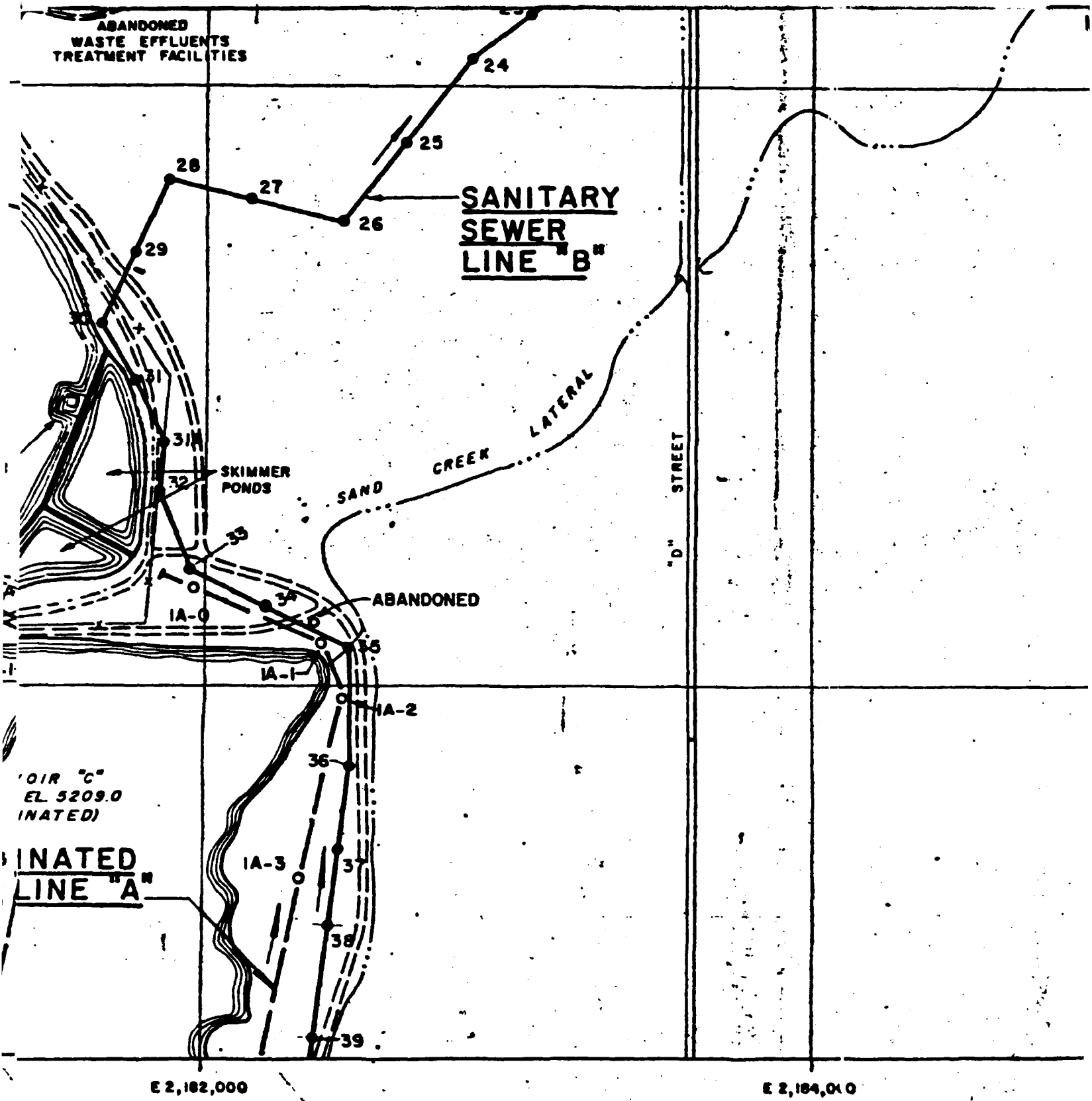
GB PLANT AREA - SANIT	
MANHOLE NO.	RIM ELEV.
S1	5224.30
S2	5223.13
S3	5224.10
S4	5224.23
S5	5223.26
S6	5223.40
S7	5211.73
S8	UNDER BLDG.
S9	5219.98
S10	5218.76
S11	5213.78
S12	5208.40
S13	5207.23
S14	5205.48
S15	5204.08
S20	5224.54
S21	5223.83
S22	5219.09
S23	5218.82
S24	5209.23
S25	5205.90
S26	5205.93
S27	5203.08
S28	ABANDONED
S30	5199.89

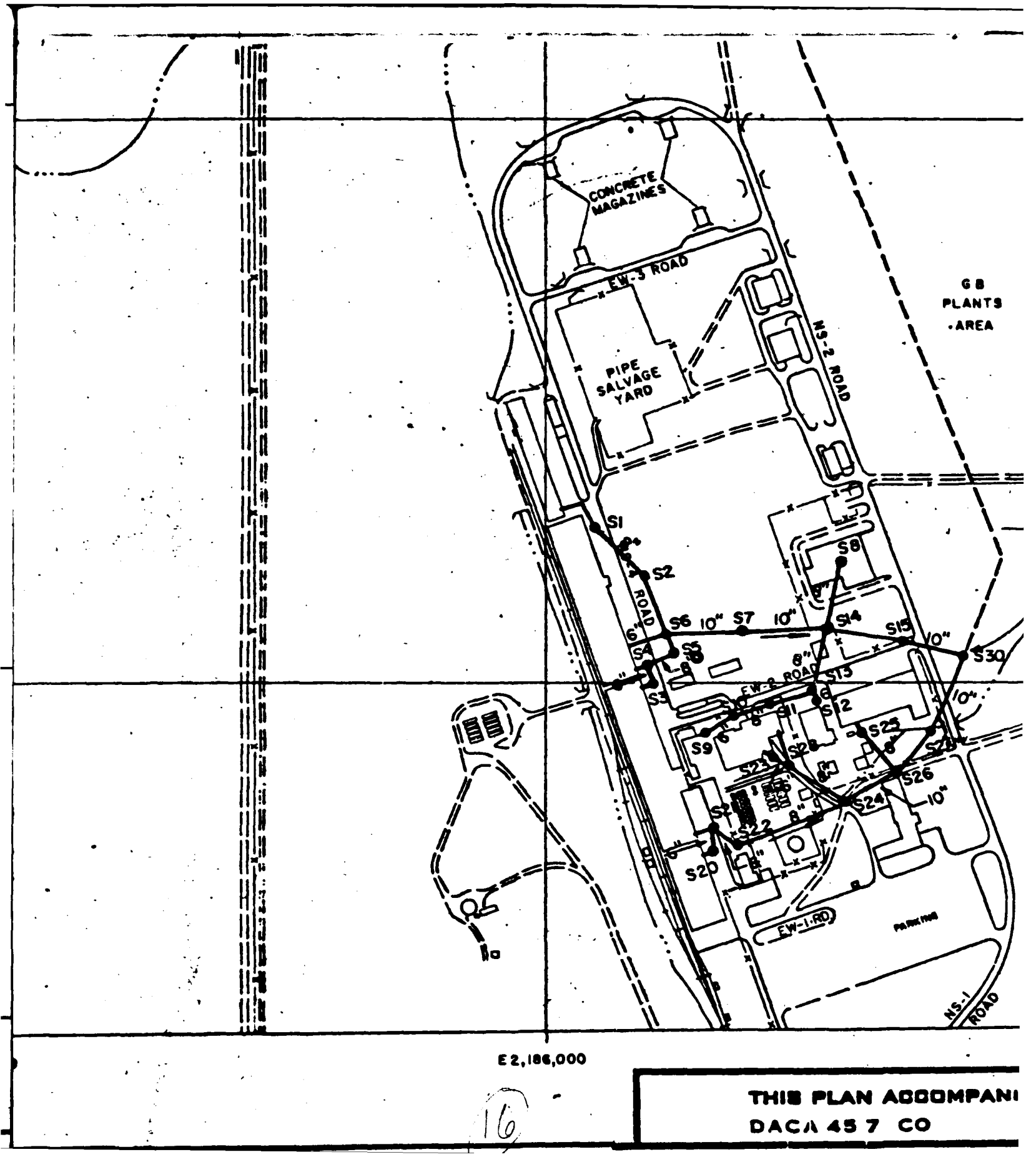


GB PLANT AREA - SANITARY SEWER LINE		
MANHOLE NO.	RIM ELEV.	INVERT ELEV.
S1	5224.30	5214.95
S2	5223.13	5213.70
S3	5224.10	5213.86
S4	5224.23	5213.23
S5	5223.26	5213.12
S6	5223.40	5208.92
S7	5211.73	5202.96
S8	UNDER BLDG.	5197.71
S9	5219.98	5211.90
S10	5218.76	5209.03
S11	5213.78	5203.64
S12	5208.40	5197.79
S13	5207.23	5196.47
S14	5205.48	5196.61
S15	5204.08	5194.53
S20	5224.54	5210.36
S21	5223.83	5209.72
S22	5219.09	5205.60
S23	5218.82	5200.09
S24	5209.23	5198.58
S25	5205.90	5195.81
S26	5205.93	5194.73
S27	5203.08	5194.32
S28	ABANDONED	
S30	5199.89	5193.68


N 190,000
N 188,000
"C" STREET
RESERVOIR "E"
HIGH WATER EL. 5180.0
(CONTAMINATED)
E 2,178,000


ABANDONED
WASTE EFFLUENTS
TREATMENT FACILITIES
28
29
RESERVOIR "F"
HIGH WATER EL. 5200.0
(CONTAMINATED)
26
31
31
COFFER
DAMS
32
SKIM
POND
33
1A-0
RESERVOIR "C"
HIGH WATER EL. 5209.0
(CONTAMINATED)
CONTAMINATED
WASTE LINE "A"
RESERVOIR "E"
HIGH WATER EL. 5180.0
(CONTAMINATED)
RESERVOIR "D"
HIGH WATER EL. 5193.0
(CONTAMINATED)
E 2,180,000
E 2,182,000

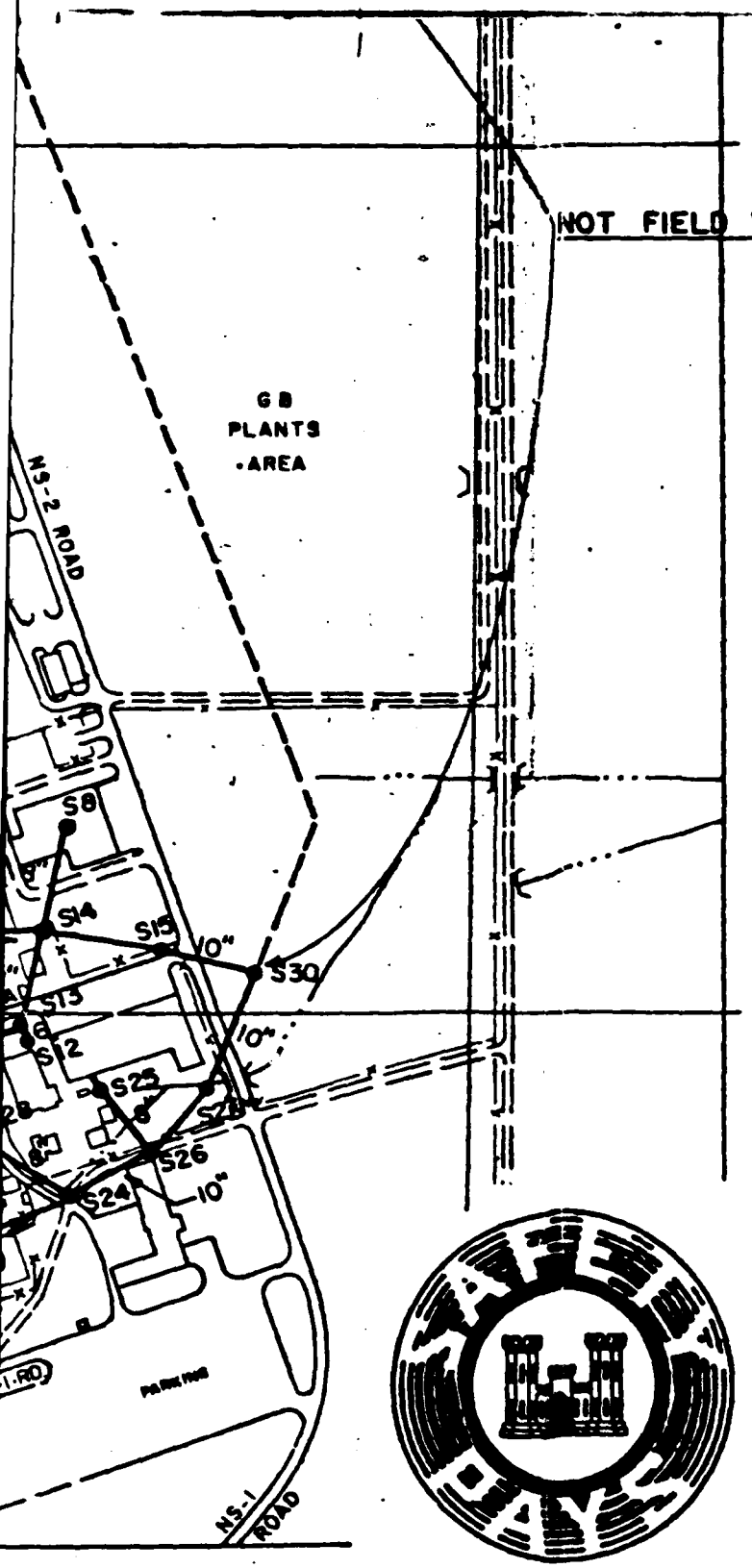




16

THIS PLAN ACCOMPANI

DACA 45 7 CO



S26	5205.93
S27	5203.08
S28	ABANDONED
S30	5199.89

DATE	DESCRIPTION

REVISION

U. S

DESIGNED BY:

DRAWN BY:

CHECKED BY:

SUBMITTED BY:

ARCHITECT-ENGINEER

RECOMMENDED:

CHIEF, DESIGN BRANCH

ROCKY MOUNTAIN ARSENAL

ARMY POLLUTIOI
SEWERAGE

ARE

SHEE

APPROVED:

CHIEF, ENGINEER DIVI

APPROVED:

COL. C. E. DISTRICT ENGINEER

SCALE: AS

SHEET

PLAN ACCOMPANIES CONTRACT No.

MODIFICATION No.

S26	5205.93	5194.73
S27	5203.08	5194.32
S28	ABANDONED	
S30	5199.89	5193.68

DESCRIPTION	MADE	APPR'D

REVISIONS

U. S. ARMY ENGINEER DISTRICT
OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO

ARMY POLLUTION ABATEMENT PROGRAM
SEWERAGE SYSTEM SURVEY

AREA PLAN
SHEET 2 OF 2

APPROVED:
CHIEF, ENGINEER DIVISION

DATE:
28 SEPT. 1979

SCALE: AS SHOWN

SPEC. NO.
DACA45

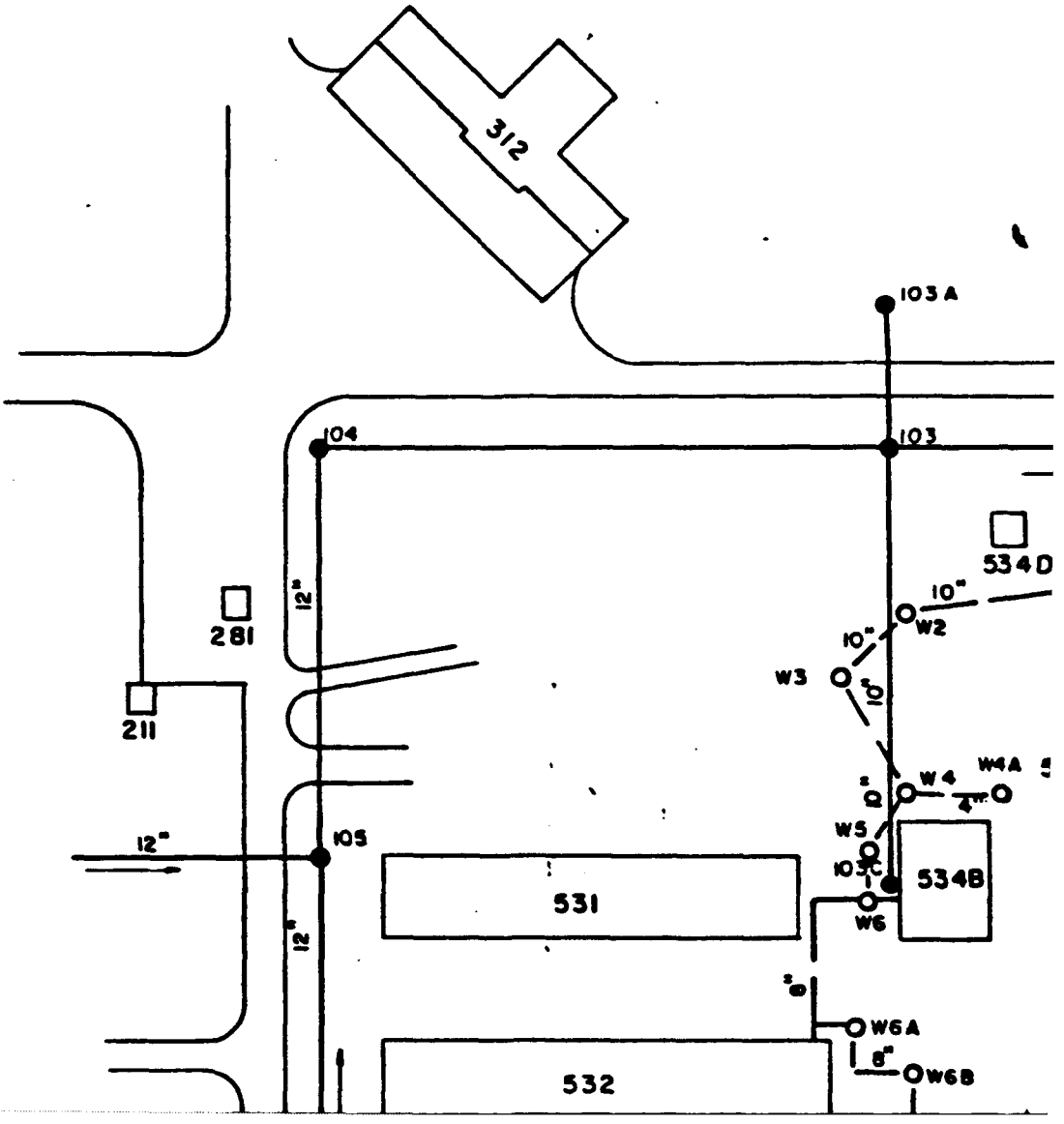
DRAWING NUMBER
S-2

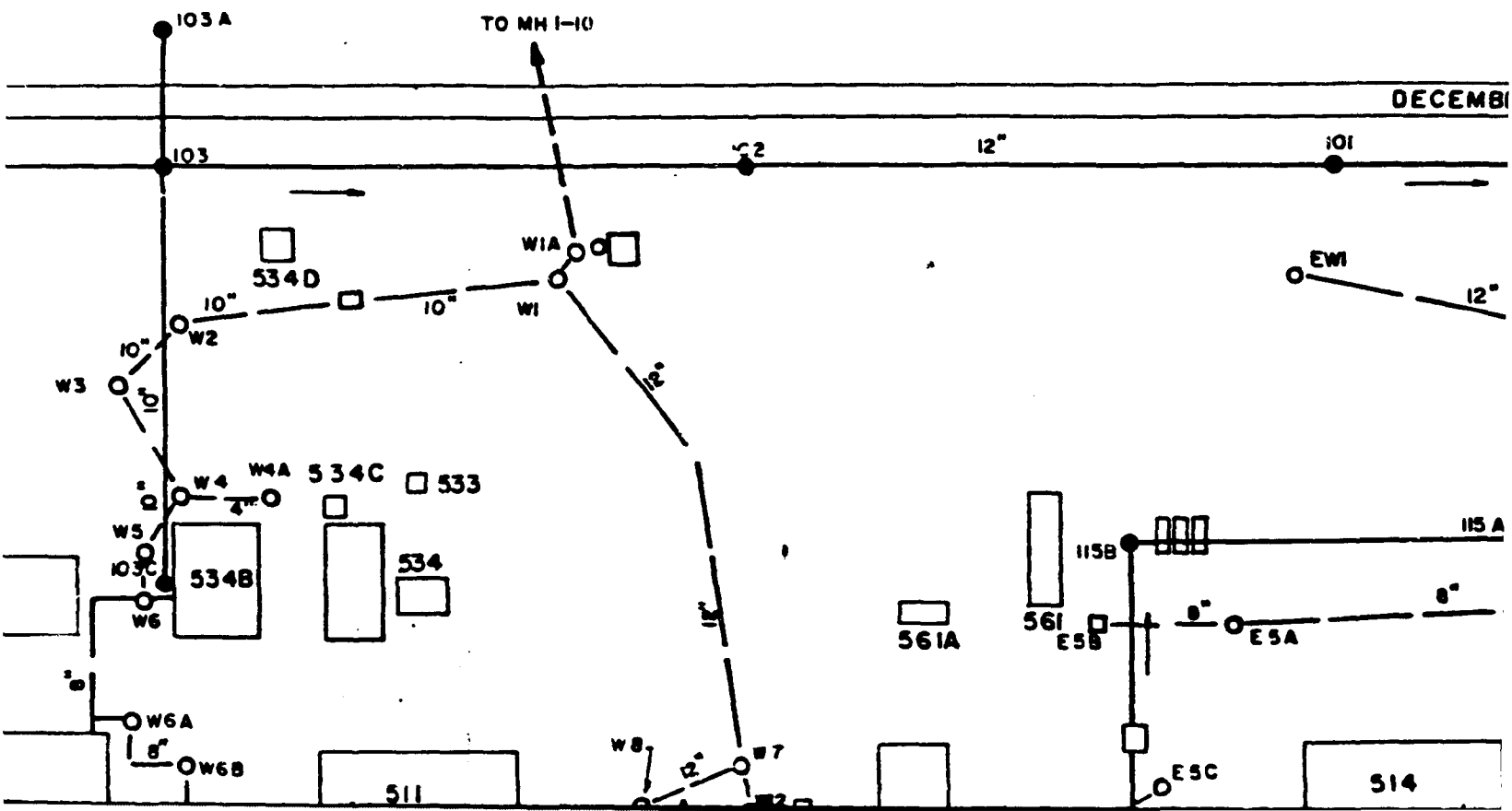
SHEET

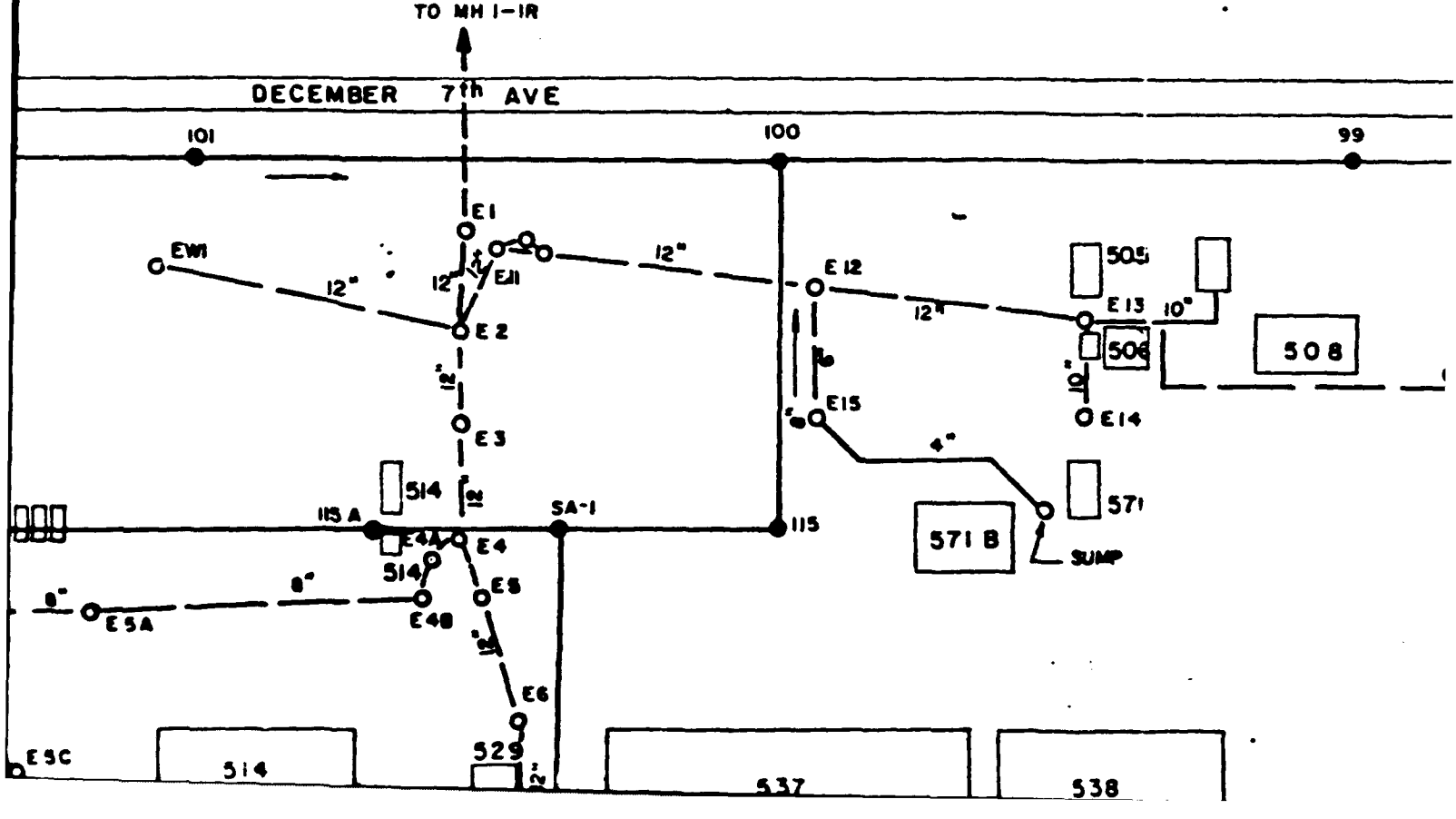
(18) 81266R35
EXTRA

U.S. GOVERNMENT PRINTING OFFICE G.P.O. 1978-768-278

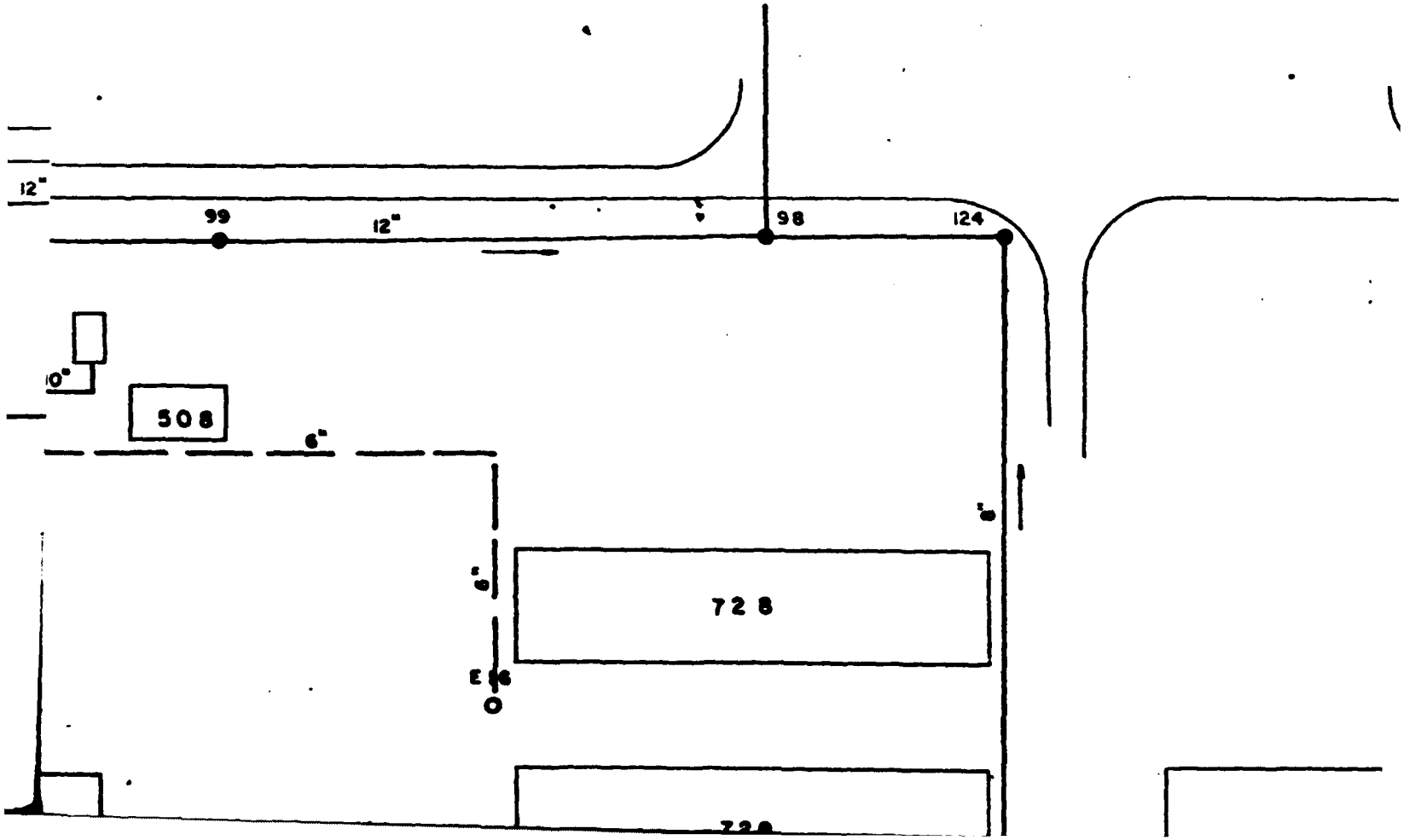
(1)


312
103 A
104
103
534D
281
211
12"
10"
W2
W3
W4
W4A
W5
105
103C
534B
W6
531
W6A
8"
W6B
532

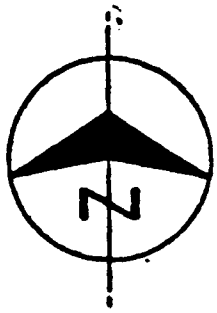

103 A
TO MH I-10
DECEMBI
103
12"
101
W1A
534 D
EW1
12"
10"
10"
W1
W2
10"
W3
10"
W4
W4A
534C
533
W5
103C
534B
534
W6
115 A
115B
561
E5B
8"
8"
E5A
561A
W6A
8"
W6B
W8
12"
W7
E5C
511
514


TO MH 1-1R
DECEMBER 7th AVE
101
100
99
E1
EW1
12"
E11
E2
E3
E12
E13
10"
E14
E15
4"
505
506
508
514
115 A
SA-1
115
E4A
E4
E4B
E5
E5A
8"
E6
E5C
529
537
538
571
571 B
SUMP

(4)



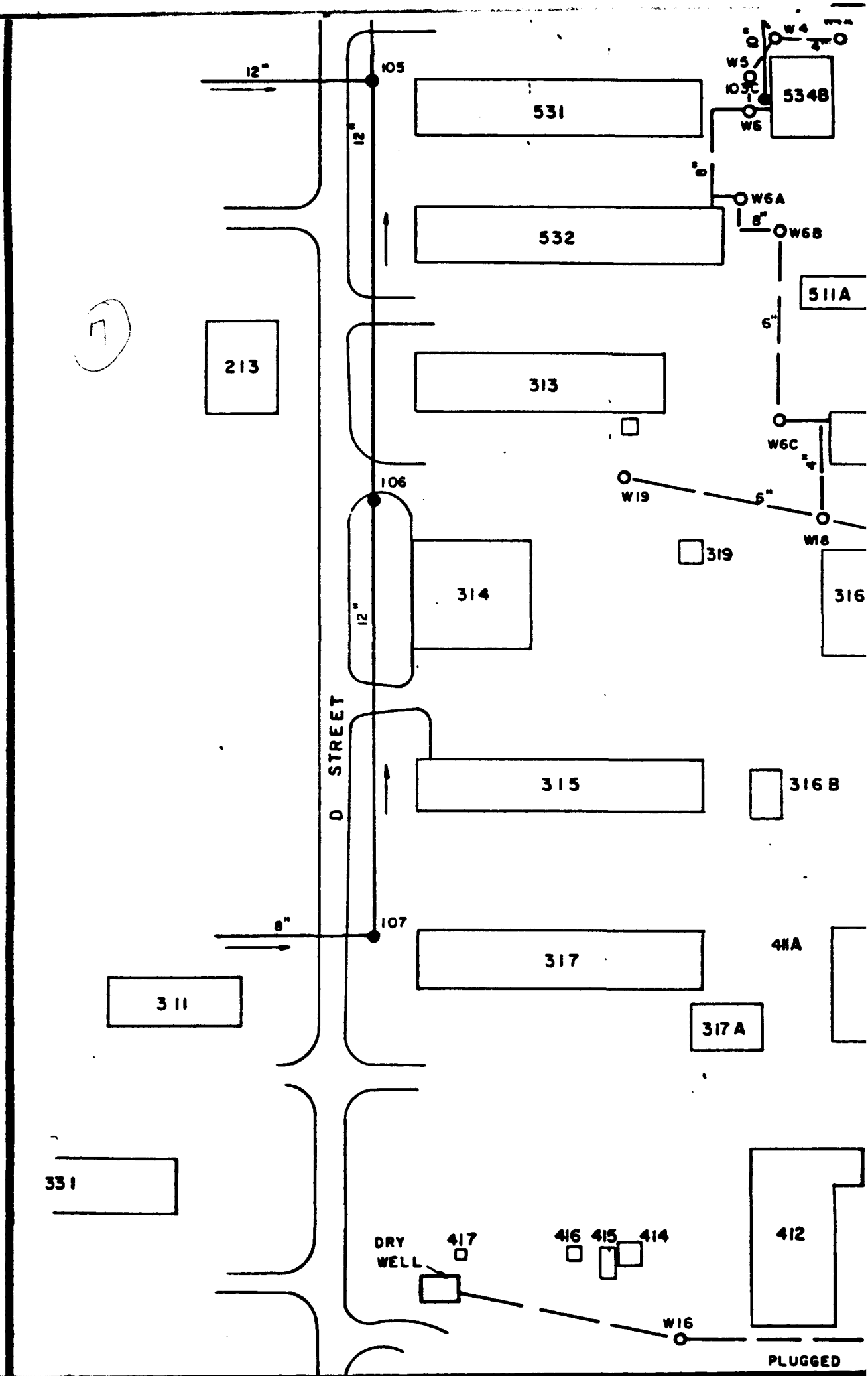
(5)

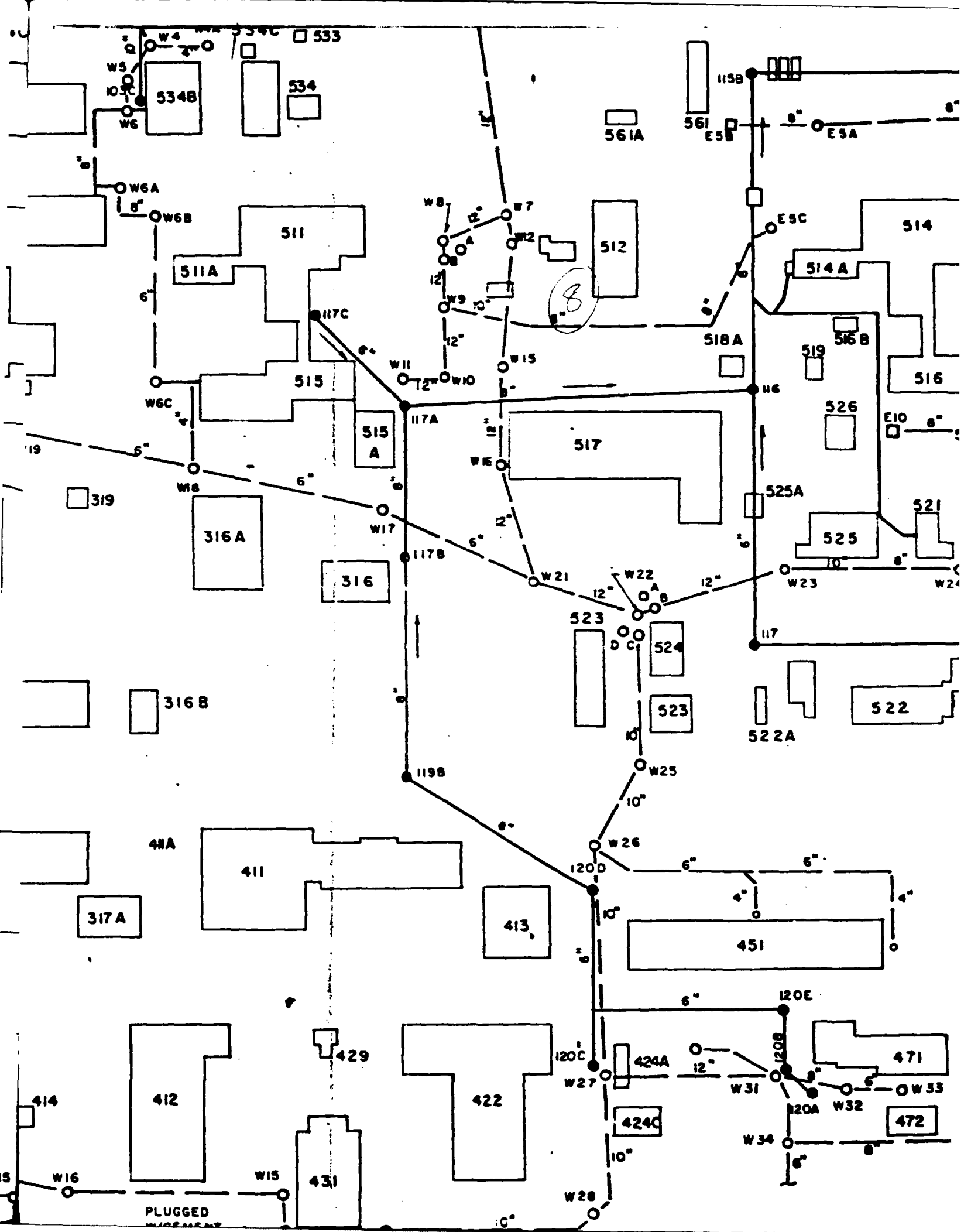


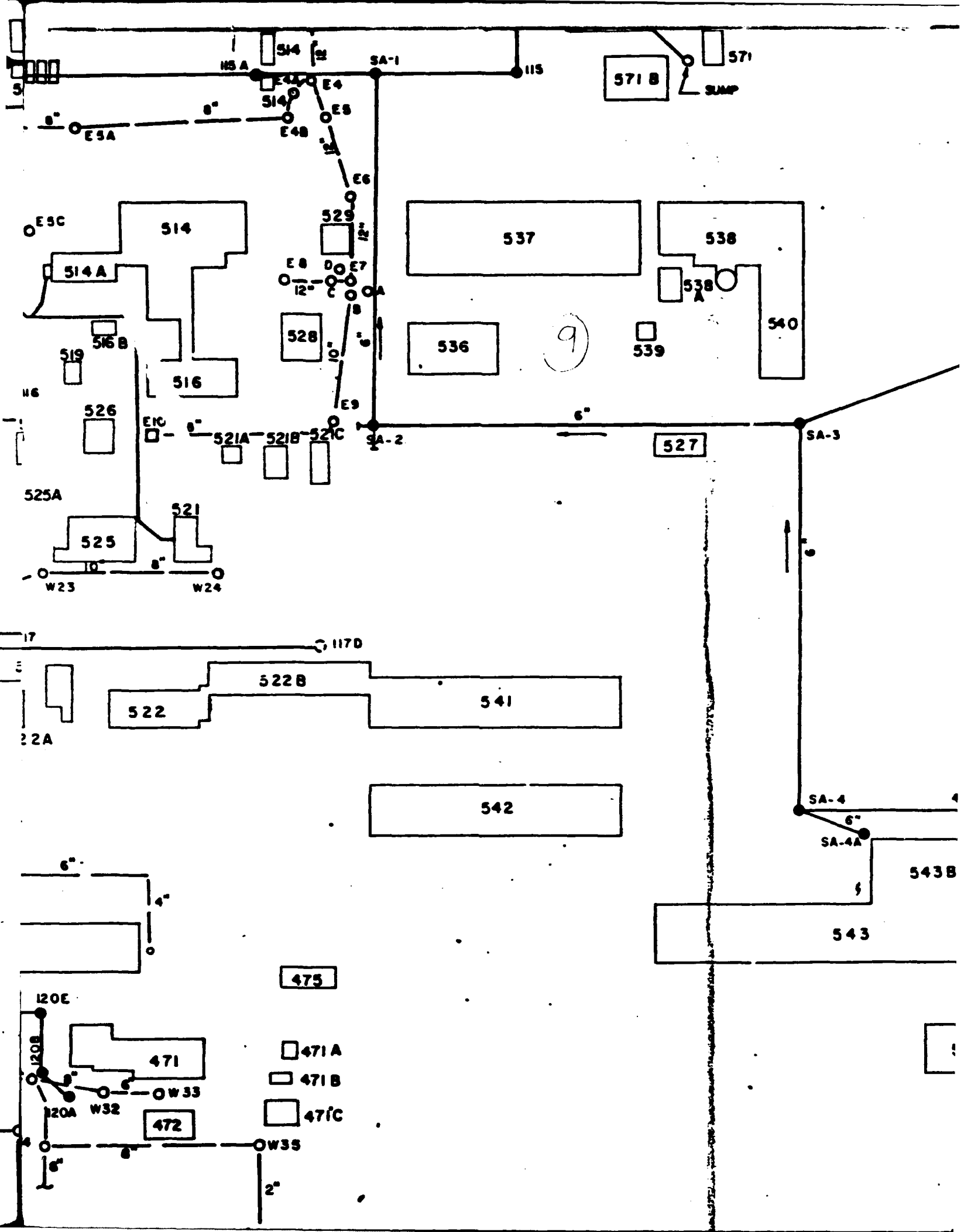
SANITARY SEWER LINE			CONT
MANHOLE NO.	RIM ELEV.	INVERT ELEV.	MANHO NO
98	5264.85	5252.10	E-1
99	5265.83	5253.00	E-3
100	5263.40	5254.15	E-4
101	5264.09	5254.92	E-4
102	5263.12	5255.70	E-5
103	5264.74	5256.49	E-5
103A	5264.21	5256.71	E-5
104	5265.73	5257.23	E-6
105	5269.18	5263.60	E-7
106	5373.63	5363.13	E-8
107	5274.45	5264.03	E-9
108	5275.39	5264.89	E-
109	5276.65	5266.57	E-
110	5277.04	5269.62	E-
110A	5271.82	5267.74	E-
111	5271.73	5267.90	E-
111A	5263.36	5259.63	W-
111B	5261.54	5257.87	W-
111D	5259.57	5255.07	W-
111E	5259.93	5251.10	W-
111J	5258.68	5253.18	W-

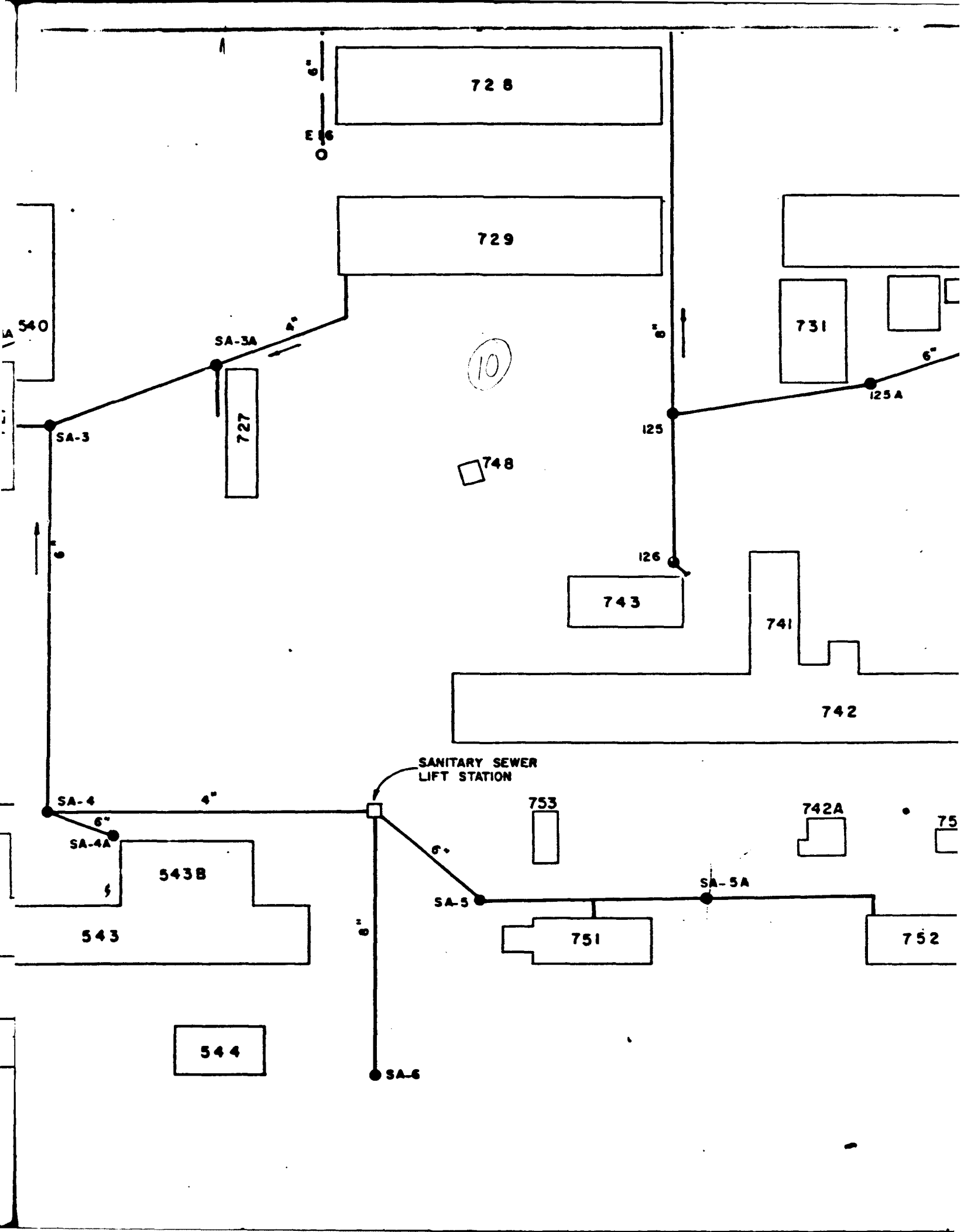
(6)

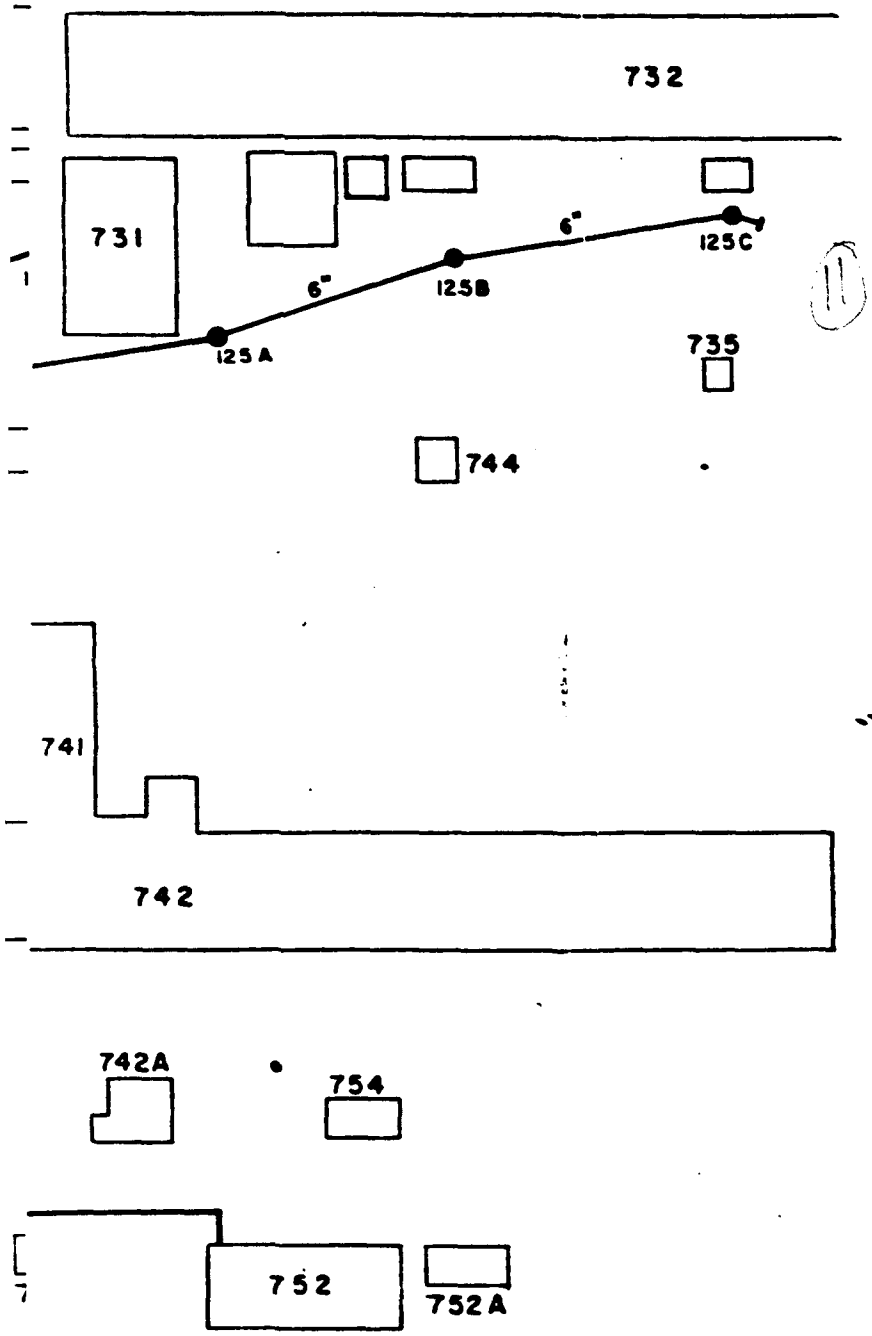
SANITARY SEWER LINE			CONTAMINATED WASTE LINE		
MANHOLE NO.	RIM ELEV.	INVERT ELEV.	MANHOLE NO.	RIM ELEV.	INVERT ELEV.
98	5264.85	5252.10	E-1	5265.25	5252.08
99	5265.83	5253.00	E-3	5265.09	5253.76
100	5263.40	5254.15	E-4	5264.66	5254.83
101	5264.09	5254.92	E-4B	5264.28	5256.28
102	5263.12	5255.70	E-5	5264.47	5254.64
103	5264.74	5256.49	E-5A	5264.48	5257.48
103A	5264.21	5256.71	E-5B	5265.03	5258.70
104	5265.73	5257.23	E-6	5263.47	5256.89
105	5269.18	5263.60	E-7	5264.34	5257.59
106	5373.63	5363.13	E-8	5271.51	
107	5274.45	5264.03	E-9	5271.33	5269.08
108	5275.39	5264.89	E-10	5273.37	5271.20
109	5276.65	5266.57	E-12	5266.16	5258.33
110	5277.04	5269.62	E-13	5266.22	5258.89
110A	5271.82	5267.74	E-15	5266.06	5261.23
111	5271.73	5267.90	E-16	5266.23	5262.15
111A	5263.36	5259.63	W-1	5264.09	5253.34
111B	5261.54	5257.87	W-2	5266.88	5257.38
111D	5259.57	5255.07	W-3	5266.78	5258.28
111E	5259.93	5251.10	W-5	5266.08	5259.08
111J	5258.68	5253.18	W-7	5264.37	5254.87


12"
105
531
12"
W5
W4
105C
534B
W6
W6A
8"
W6B
532
511A
6"
213
313
W6C
106
W19
6"
W18
319
314
316
12"
D STREET
315
316 B
8"
107
317
411A
311
317 A
331
DRY WELL
417
416
415
414
412
W16
PLUGGED


W4
W5
W6
534B
534
533
561A
561
E5B
E5A
W6A
W6B
511
511A
W8
W7
W12
512
E5C
514
514A
W9
518A
516B
519
516
117C
W11
W10
W15
515
W6C
117A
526
E10
515A
517
W16
525A
521
319
W18
316A
W17
117B
W21
W22
W23
525
316
523
524
117
316B
522
522A
523
W25
1198
W26
120D
411A
411
317A
413
451
120E
429
120C
424A
W27
W31
120B
471
414
412
422
120A
W32
W33
424C
472
W34
W16
W15
431
W28
PLUGGED


514
115 A
SA-1
115
571
571 B
SUMP
E4A
E4
514
E5
E5A
E4B
8"
E6
E5C
529
514
537
538
514 A
E8
D
E7
C
B
A
538 A
528
536
539
540
516 B
519
516
526
E10
521A
521B
521C
SA-2
527
SA-3
525A
521
525
W23
W24
117
117D
522B
522
541
22A
542
SA-4
SA-4A
543B
543
6"
4"
475
120E
120B
471
471 A
471 B
471C
W33
W32
120A
472
W35
2"


728
729
731
540
SA-3A
4"
SA-3
727
748
125A
125
126
743
741
742
SANITARY SEWER
LIFT STATION
SA-4
4"
6"
SA-4A
753
742A
543B
543
SA-5
SA-5A
751
752
544
SA-6



110A	5271.82	5267.74	E-15
111	5271.73	5267.90	E-16
111A	5263.36	5259.63	W-1
111B	5261.54	5257.87	W-2
111D	5259.57	5255.07	W-3
111E	5259.93	5251.10	W-5
111J	5258.68	5253.18	W-7
112	5270.13	5261.71	W-8
113	5269.90	5262.48	W-12
115A	5264.93	5254.93	W-15
115B	5262.10	5254.35	W-16
117	5270.59	5264.09	W-18
117A	5667.71	5259.46	W-21
117B	5271.17	5259.34	W-22
117C	5266.28	5261.20	W-23
119B	5274.12	5260.20	W-25
120A	5272.27	5268.52	W-26
120C	5271.38	5266.46	W-27
120D	5273.01	5263.83	W-28
124	5261.83	5252.83	W-29
S-1	5275.17	5269.67	W-30
S-2	5274.64	5268.97	W-31
S-3	5275.29	5268.12	W-32
S-5	5273.91	5266.24	W-33
S-6	5271.64	5262.47	
S-7	5273.23	5264.98	
S-9	5274.07	5267.07	
SA-2	5265.05	5259.37	

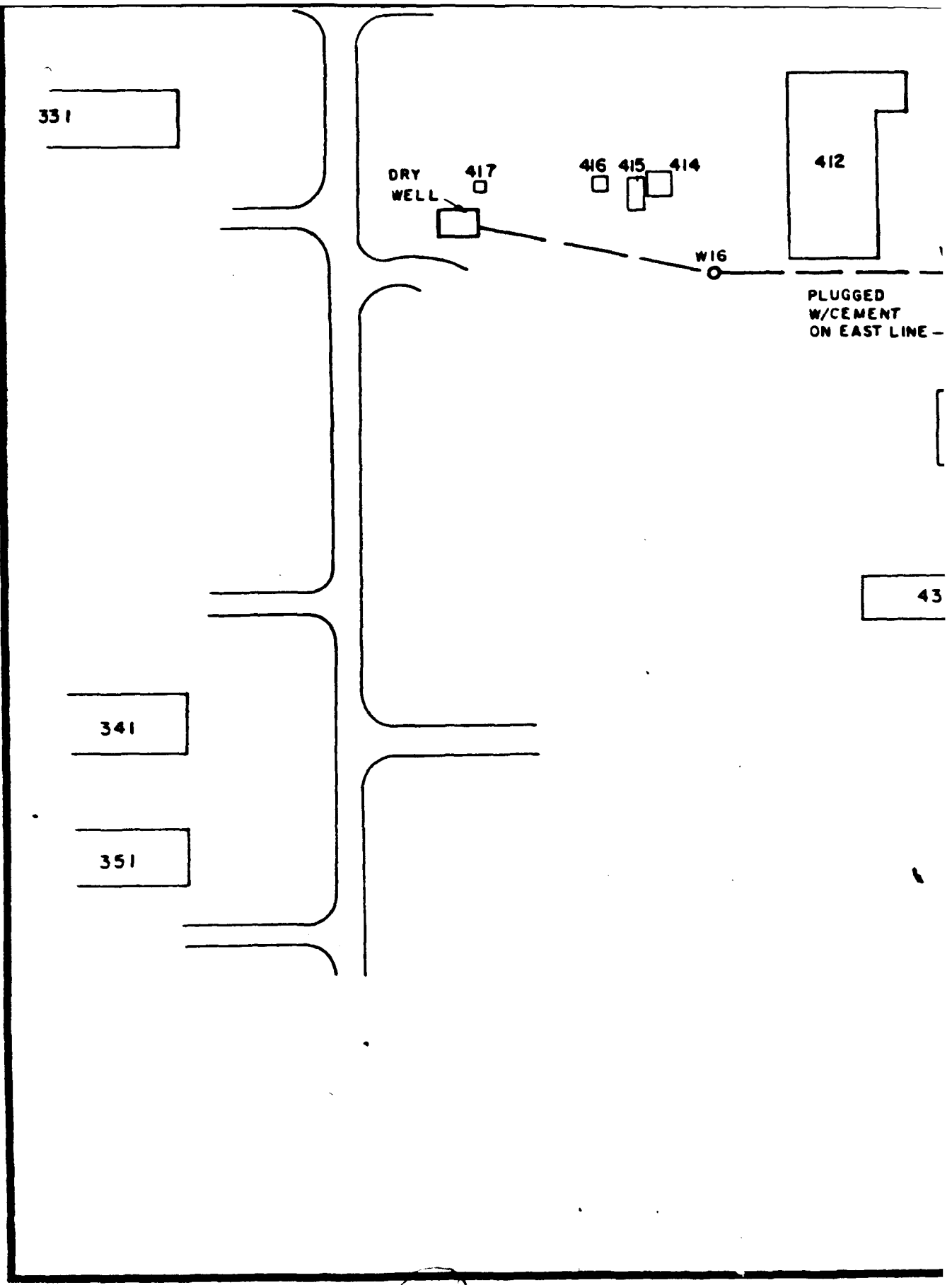
NOTE:

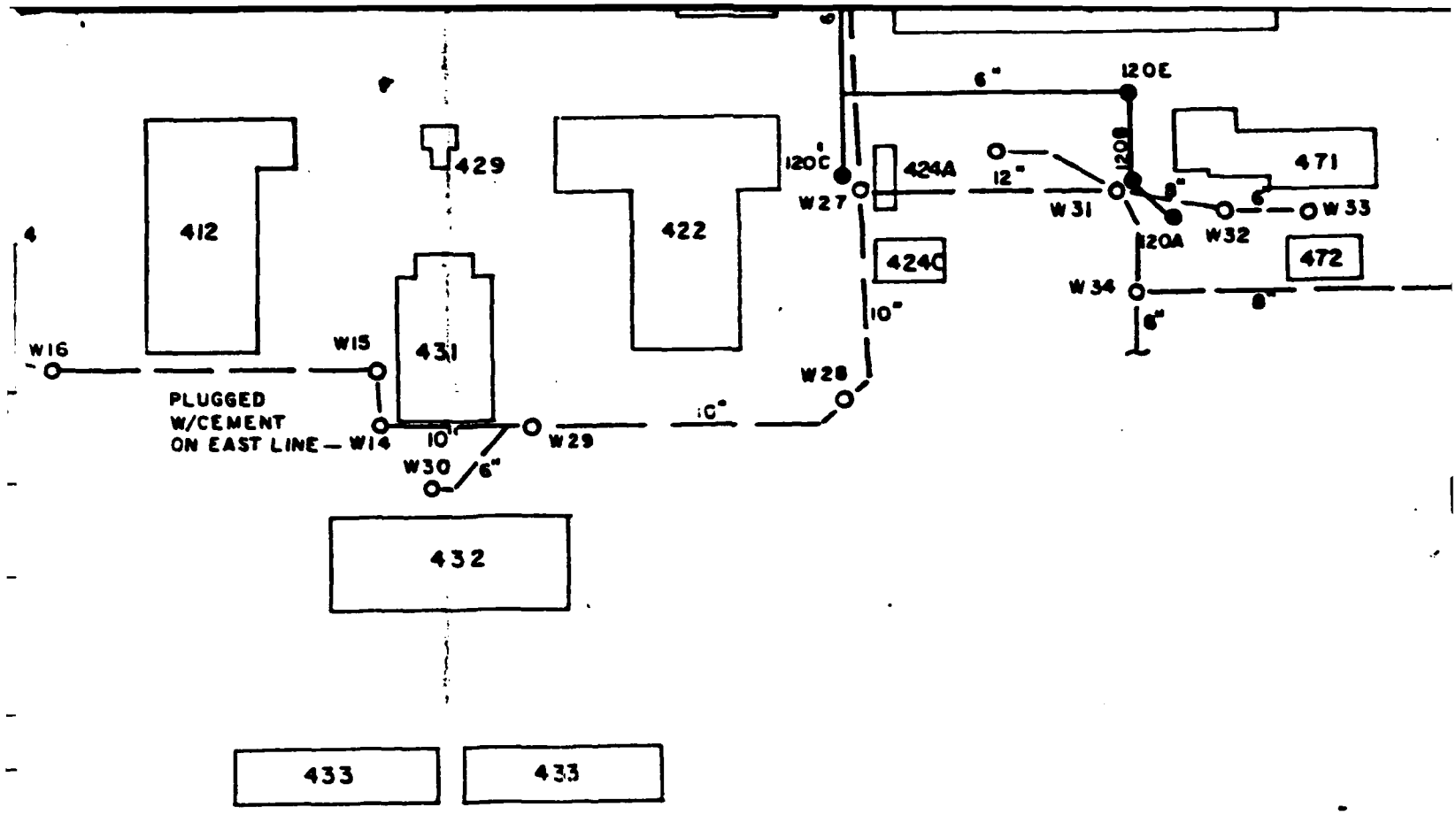
1. DATA FOR MANHOLES SHOWN ON MAPS A TABLE ABOVE COULD NOT BE OBTAINED

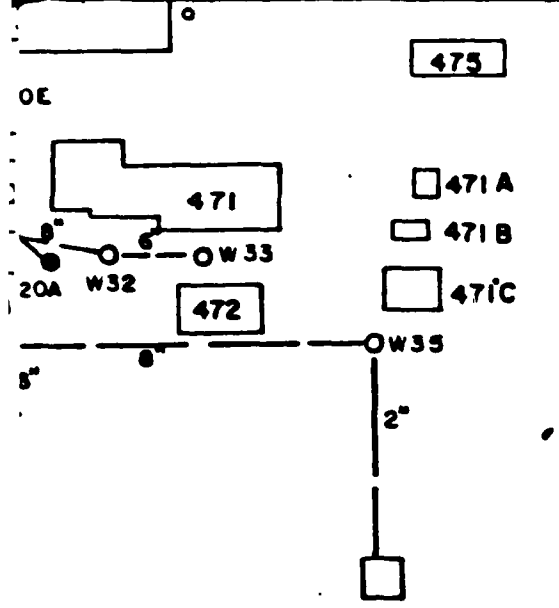
100' 50' 0 100' 2(

271.82	5267.74	E-15	5266.06	5261.23
271.73	5267.90	E-16	5266.23	5262.15
263.36	5259.63	W-1	5264.09	5253.34
261.54	5257.87	W-2	5266.88	5257.38
259.57	5255.07	W-3	5266.78	5258.28
259.93	5251.10	W-5	5266.08	5259.08
258.68	5253.18	W-7	5264.37	5254.87
270.13	5261.71	W-8	5263.97	5255.55
269.90	5262.48	W-12	5263.91	5257.74
264.93	5254.93	W-15	5266.78	5259.53
262.10	5254.35	W-16	5268.25	
270.59	5264.09	W-18	5268.78	5265.95
567.71	5259.46	W-21	5270.59	5262.84
271.17	5259.34	W-22	5271.83	5263.33
266.28	5261.20	W-23	5271.03	5267.45
274.12	5260.20	W-25	5271.38	5264.38
272.27	5268.52	W-26	5273.28	5264.78
271.38	5266.46	W-27	5271.39	5265.39
273.01	5263.83	W-28	5271.71	5265.21
261.83	5252.83	W-29	5270.71	5266.46
275.17	5269.67	W-30	5271.51	5267.75
274.64	5268.97	W-31	5272.74	5265.49
275.29	5268.12	W-32	5272.06	5267.06
273.91	5266.24	W-33	5271.53	5268.20
271.64	5262.47			
273.23	5264.98			
274.07	5267.07			
265.05	5259.37			

N MANHOLES SHOWN ON MAPS AND NOT LISTED IN
OVE COULD NOT BE OBTAINED.


331
DRY WELL
417
416
415
414
412
W16
PLUGGED W/CEMENT ON EAST LINE
43
341
351


412
429
422
120C
424A
6"
120E
471
12"
120B
W31
W27
W33
W32
120A
424C
472
W34
10"
8"
6"
W16
W15
431
W28
PLUGGED
W/CEMENT
ON EAST LINE — W14
10"
W29
W30
6"
432
433
433



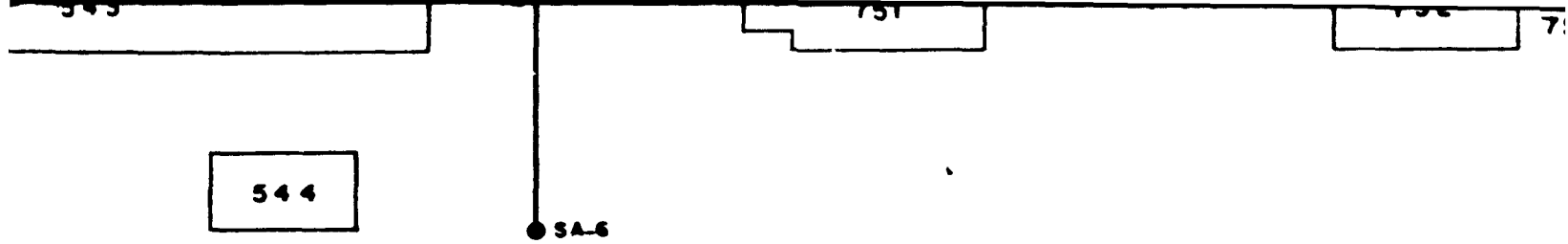
544

LEGEND

SANITARY SEWER LINE & MANHOLE

CONTAMINATED WASTE LINE & MANH

DIRECTION OF FLOW



LINE & MANHOLE

STE LINE & MANHOLE

)W

THIS PLAN ACCOMPANIES CONTR
DACA 45 7 CO MODIFICA

GINEERING — $$

752

752A

NOTE:

1. DATA FOR MANHOLES SHOWN ON MAPS AN
TABLE ABOVE COULD NOT BE OBTAINED.

100' 50' 0 100' 200

1" = 100'

DATE	DESCRIPTION

REVISIONS

U. S. ARM

COR
OI

DESIGNED BY:

DRAWN BY:

CHECKED BY:

SUBMITTED BY:

ARCHITECT-ENGINEER

ROCKY MOUNTAIN ARSENAL

ARMY POLLUTION AB/
SEWERAGE SYSTE
SOUTH PLAN
SHEET 1 OF

RECOMMENDED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, ENGINEER DIVISION

APPROVED:

COL C. E. DISTRICT ENGINEER

SCALE: AS SHOWN

SHEET

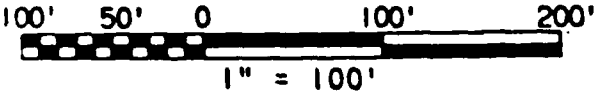
ACCOMPANIES CONTRACT No.

CO MODIFICATION No.

(17) ✓ 1st FIRM

U.S. GOVERNMENT PRINTING OFFICE G.P.O

ATA FOR MANHOLES SHOWN ON MAPS AND NOT LISTED IN
ABLE ABOVE COULD NOT BE OBTAINED.



DESCRIPTION	MADE	APPR'D

REVISIONS

U. S. ARMY ENGINEER DISTRICT
OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO

ARMY POLLUTION ABATEMENT PROGRAM
SEWERAGE SYSTEM SURVEY
SOUTH PLANT AREA
SHEET 1 OF 2

APPROVED:
CHIEF, ENGINEER DIVISION

DATE:
28 SEPT. 1979

SCALE: AS SHOWN

SPEC. NO.
DACA45

DRAWING NUMBER
S-17

RICT ENGINEER

SHEET

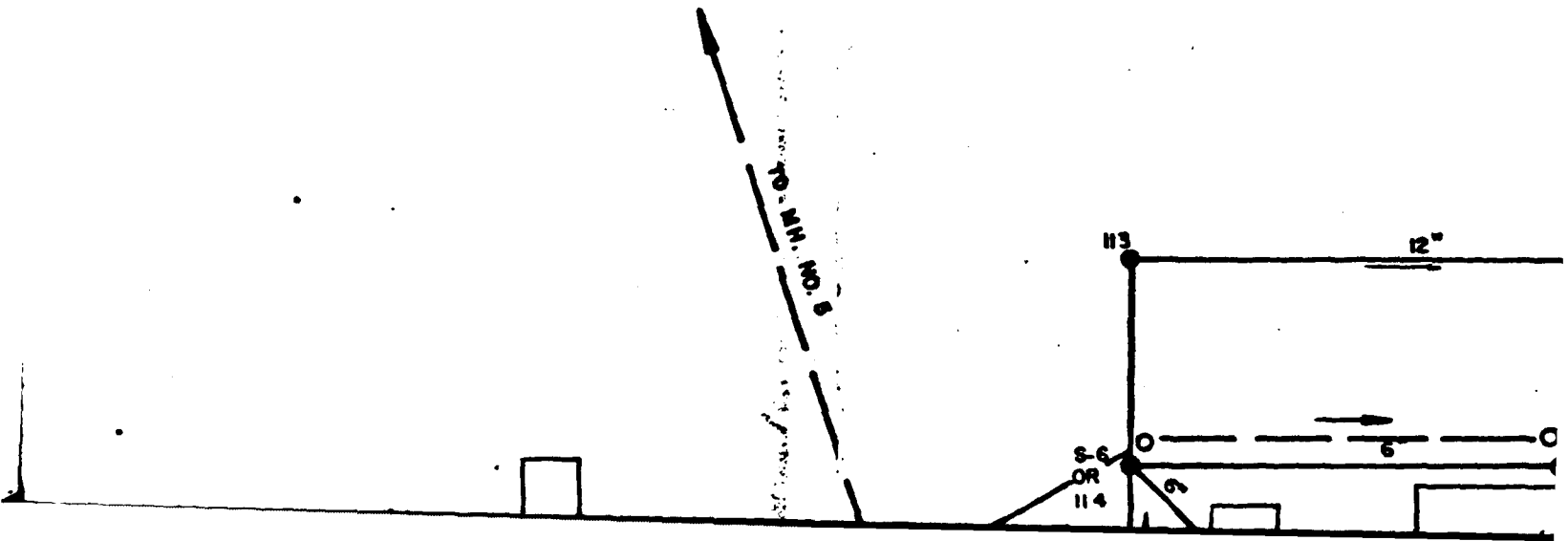
81266R35
EXTRA

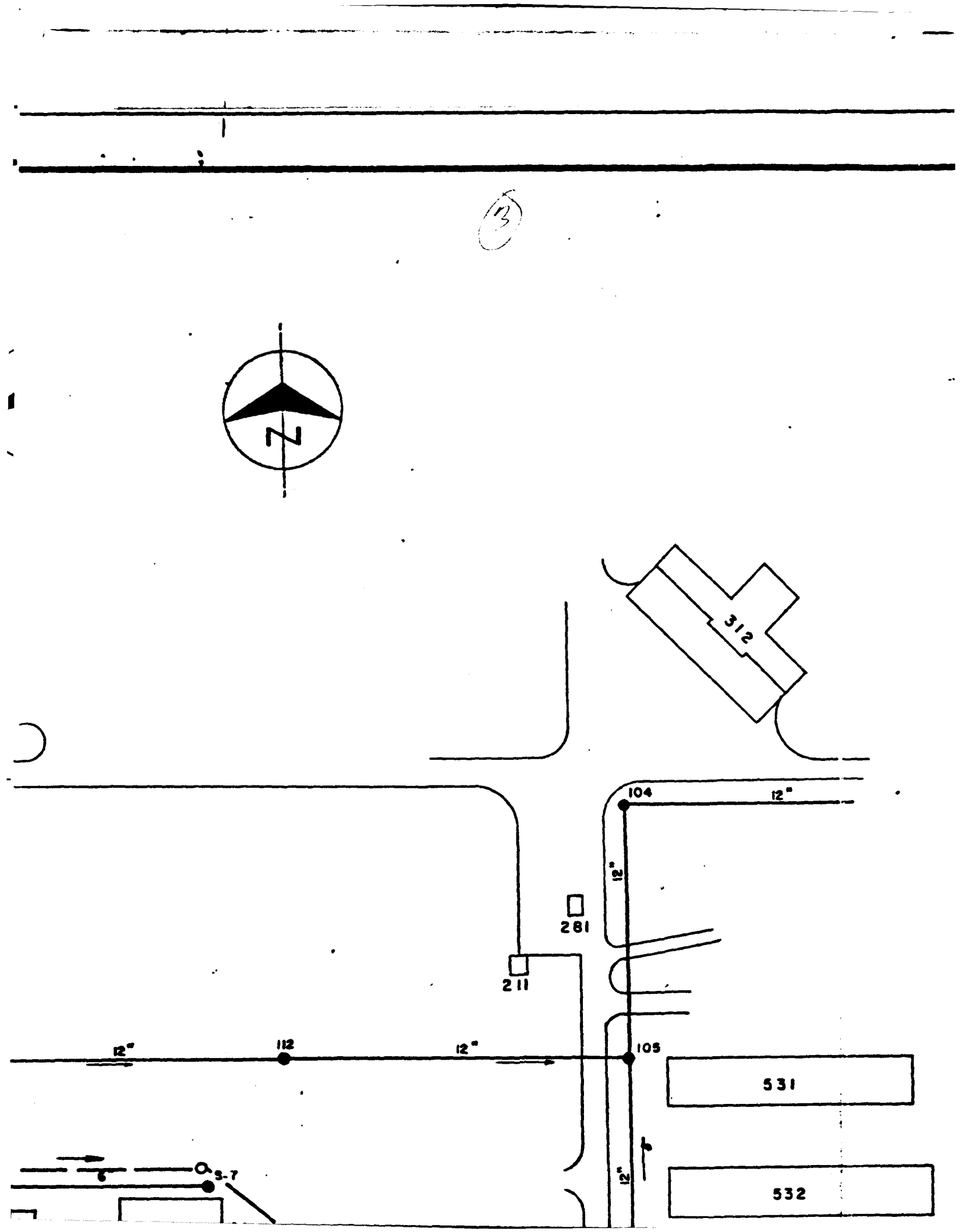
U.S. GOVERNMENT PRINTING OFFICE G.P.O. 1978-768-278

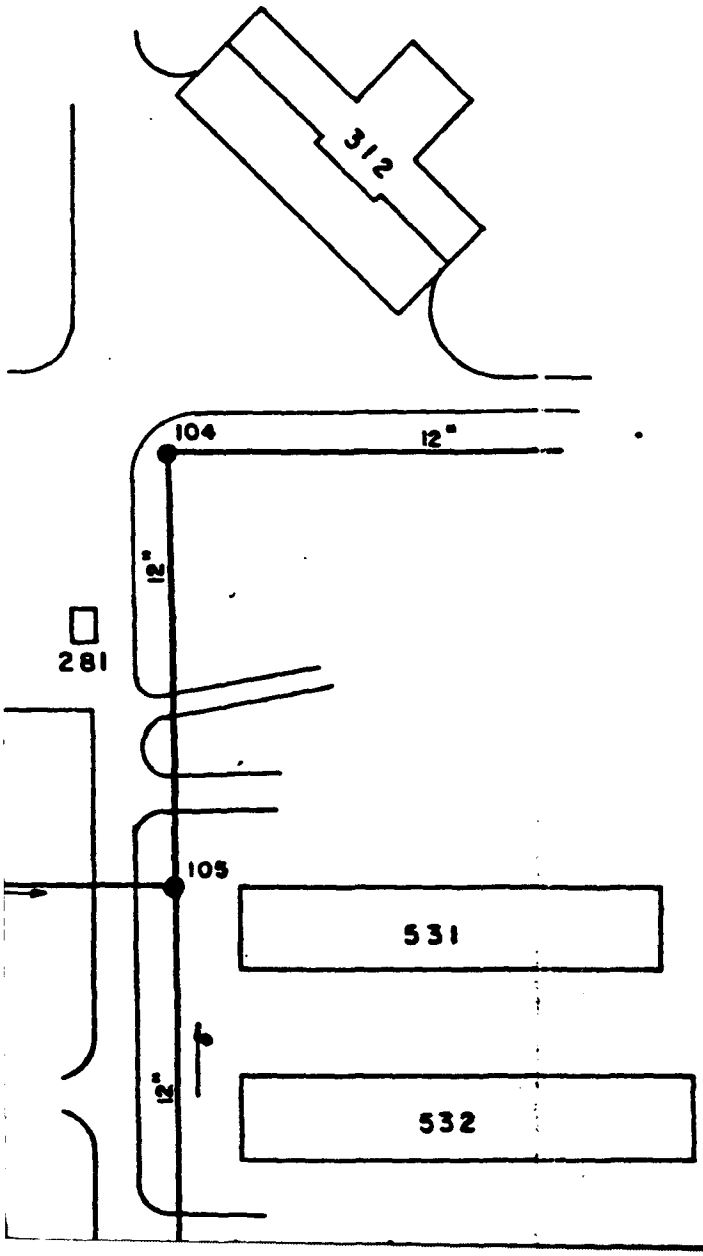
(1)

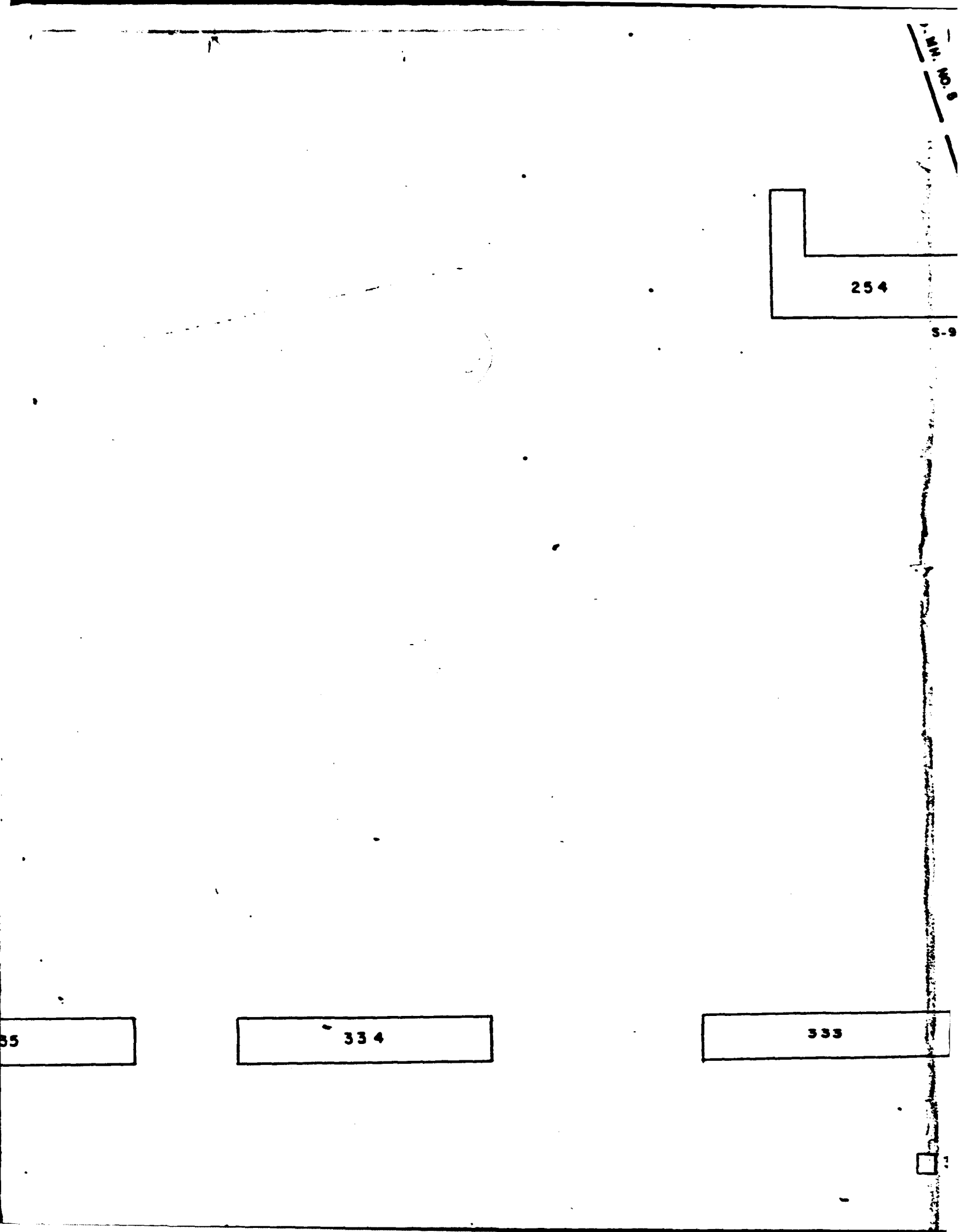
DECEMBER 7th AVENUE

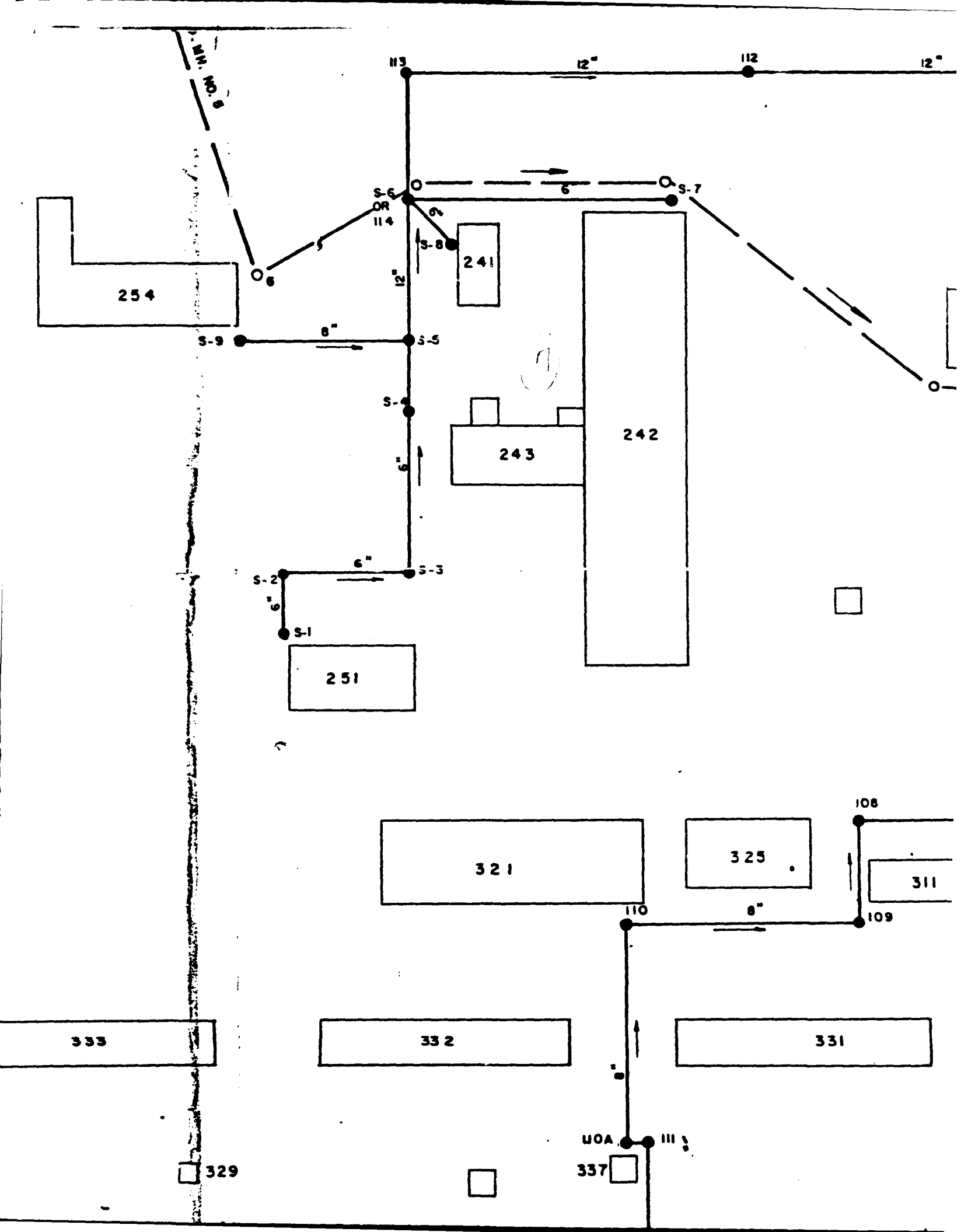
(2)

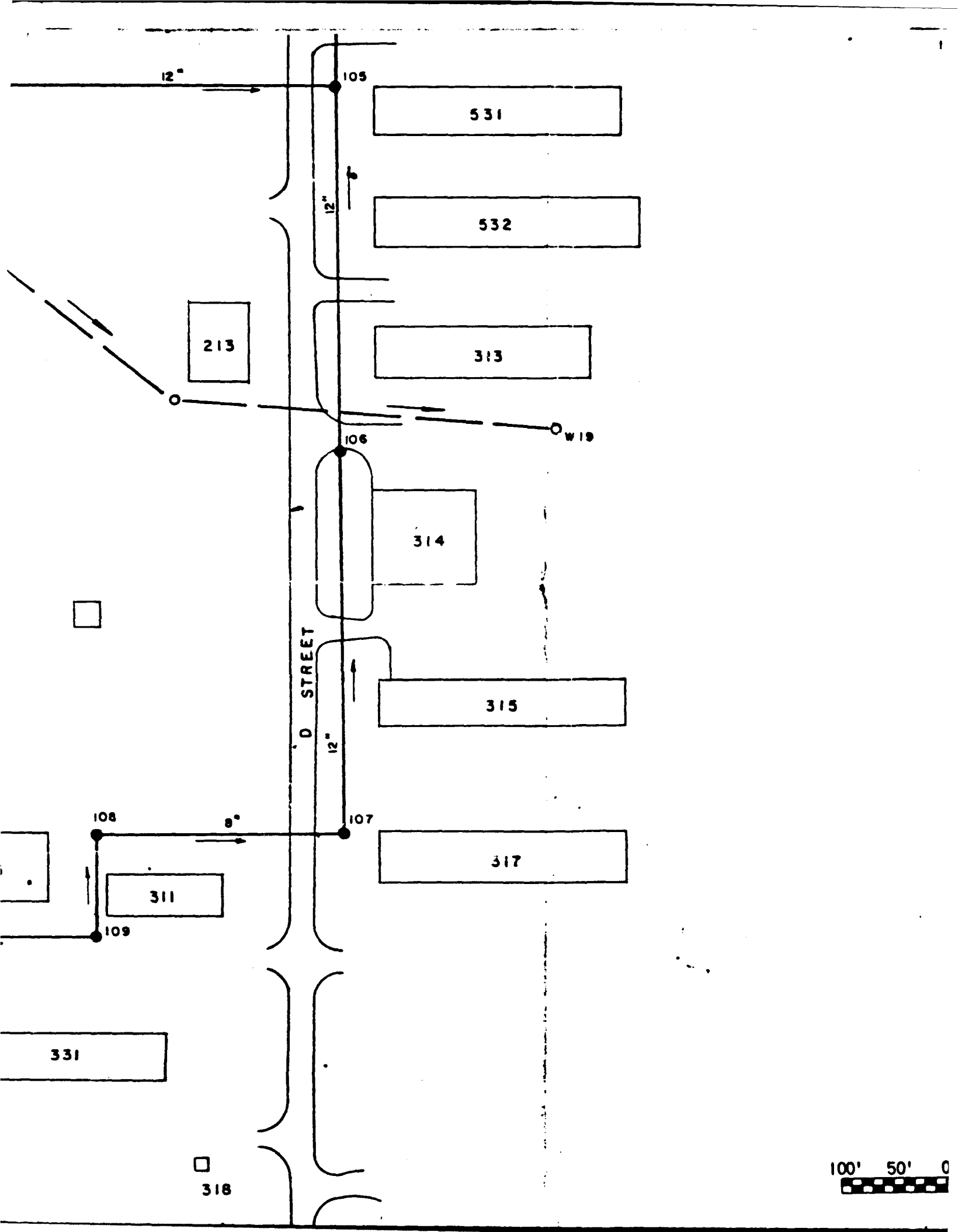


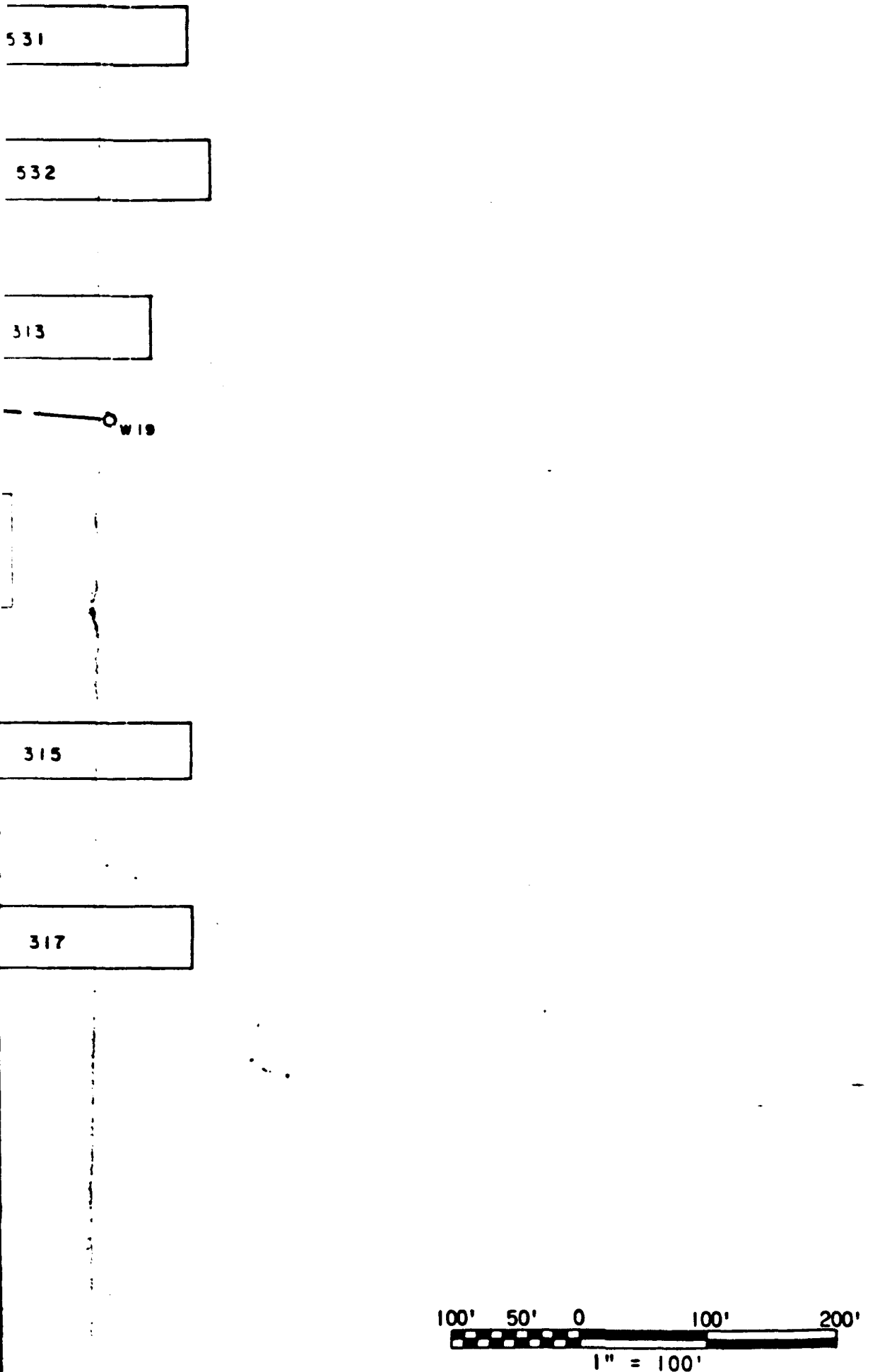

N
312
104
12"
12"
281
211
12"
112
12"
105
531
532
12"
S-7

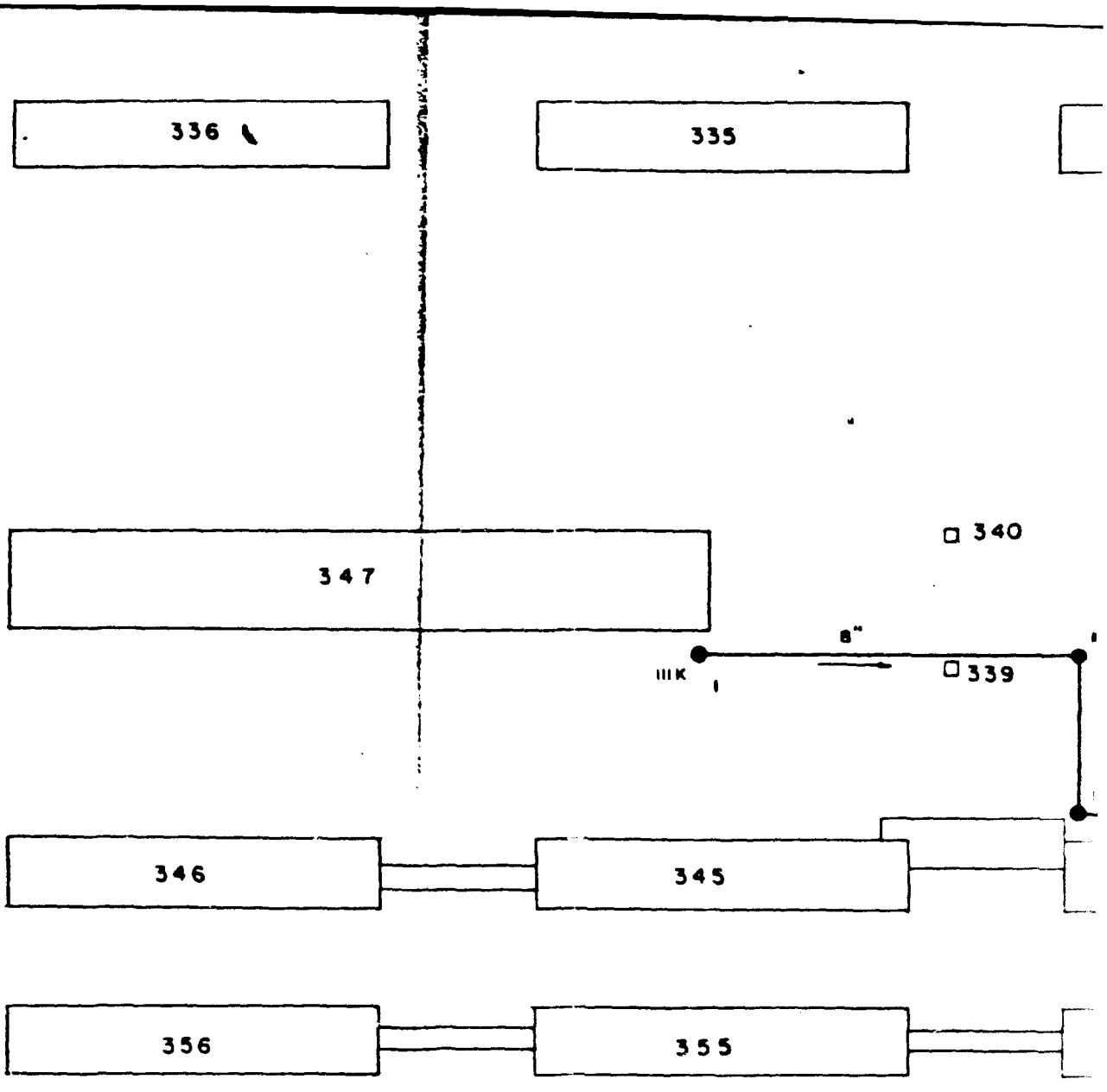

312
104
12"
12"
281
105
531
12"
532

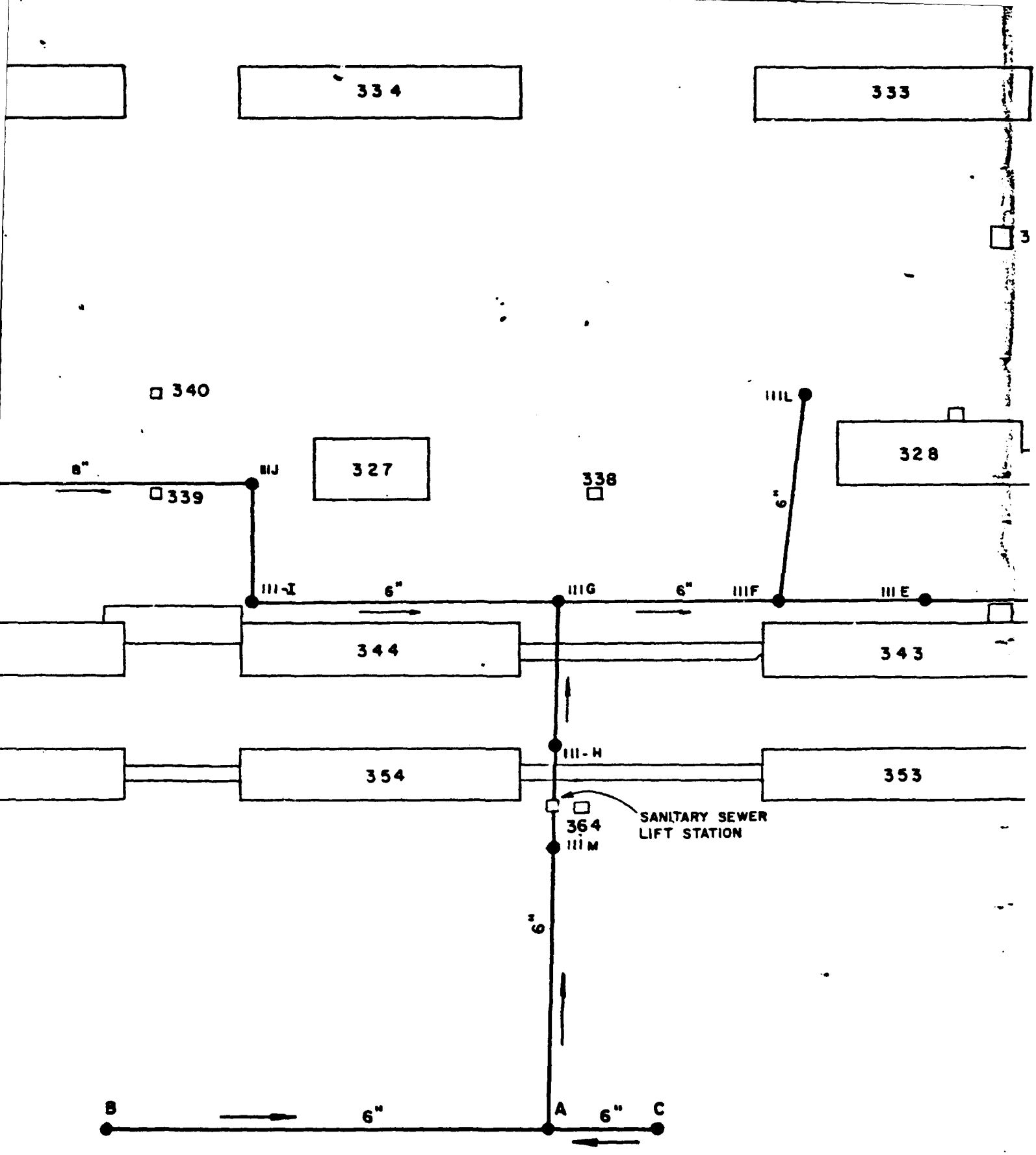

N.W. NO. 9
254
S-9
85
334
333

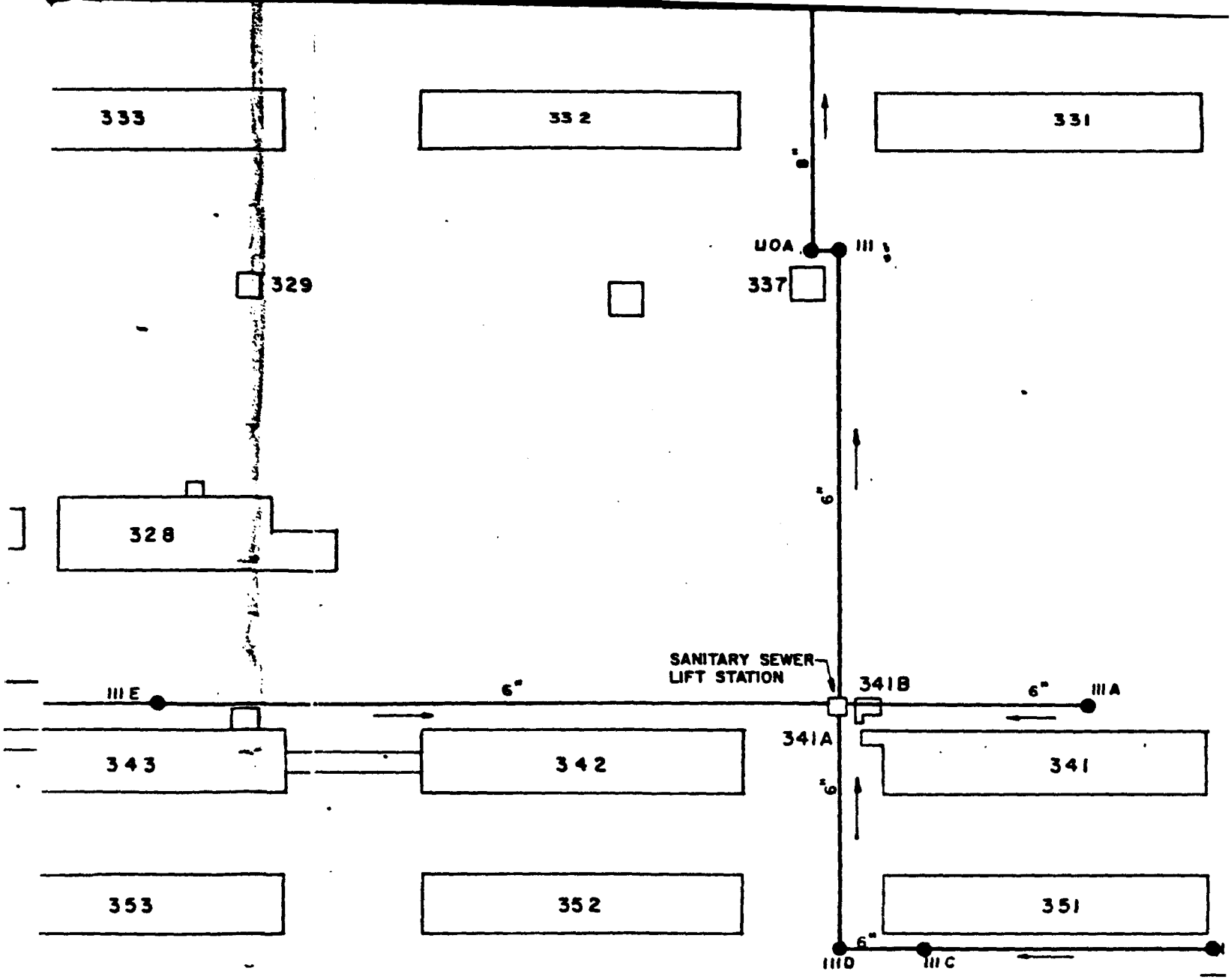

113
12"
112
12"
8" MH
S-6
OR
114
6
S-7
6
6"
S-8
241
12"
254
6
8"
S-9
S-5
S-4
242
243
6"
6"
S-2
S-3
S-1
251
108
321
325
311
110
8"
109
333
332
331
8"
110A
111
329
337


12"
105
531
12"
532
213
313
W 19
106
314
D STREET
315
12"
108
8"
107
317
311
109
331
318
100'
50'
0


531
532
313
W 19
315
317
100' 50' 0 100' 200'
1" = 100'


336
335
347
340
8"
339
346
345
356
355
8


334
333
340
339
327
338
328
8"
III J
III L
6"
III-I
6"
III G
6"
III F
III E
344
343
354
353
III-H
364
III M
SANITARY SEWER
LIFT STATION
6"
B
6"
A
6"
C



THIS P
DACA

THINK VALUE ENGINEERING — $$

12

331

318

100' 50'

6" 111A

341

351

111B

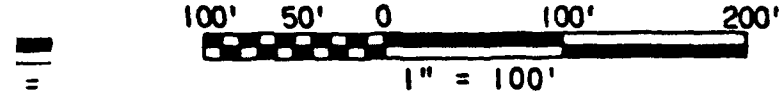
DATE	

DESIGNED BY:	ROCKY M
DRAWN BY:	ARMY
CHECKED BY:	
SUBMITTED BY: ARCHITECT-ENGINEER	
RECOMMENDED: CHIEF, DESIGN BRANCH	APPROVED:
APPROVED:	

THIS PLAN ACCOMPANIES CONTRACT No.
DACA 45 7. CO MODIFICATION No.

COL. C. E. DISTRICT ENGINEER

(13)



	DESCRIPTION	MADE	APPR'D

REVISIONS

U. S. ARMY ENGINEER DISTRICT
OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO

ARMY POLLUTION ABATEMENT PROGRAM
SEWERAGE SYSTEM SURVEY
SOUTH PLANT AREA
SHEET 2 OF 2

APPROVED:
CHIEF, ENGINEER DIVISION

DATE:
28 SEPT. 1979

SCALE: AS SHOWN

SPEC. NO.
DACA45

DRAWING NUMBER
S-18

SHEET

DISTRICT ENGINEER